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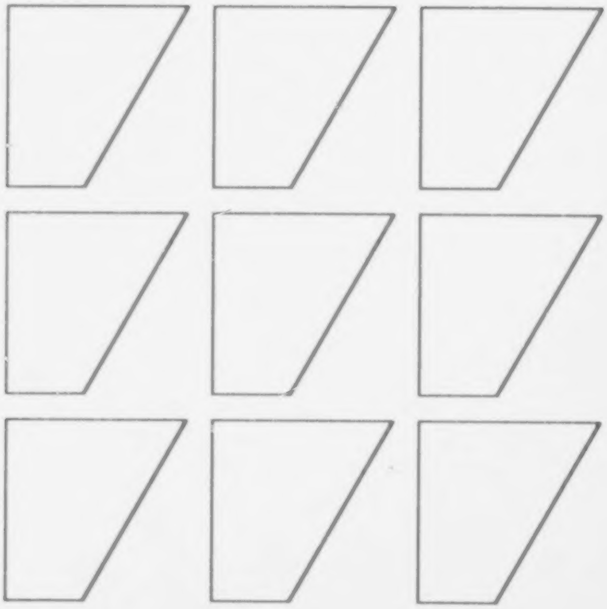
The Transformation of the European Financial Services Industry: From Fragmentation to Integration

By Gabriel Hawawini
Eric Rajendra



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By Gabriel Hawawini
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I. Introduction

Two points of consensus in the global financial community appears to have emerged: one, that we are witnessing a historically unparalleled transformation of the European financial services industry and, two, that the complete integration of Europe's fragmented financial markets will take longer to achieve than by the morning of January 1, 1993. Europe's financial sector is currently engaged in a long, complex, and irreversible process of change, some aspects of which are examined in this monograph.

Specifically, we attempt to synthesize the evolving structure and dynamics of the EEC's financial sector and evaluate the effects of various factors of change on European users and providers of financial products and services. Faced with a choice between a broad coverage of all aspects of the financial services industry or an extremely detailed analysis of one particular sub-sector, we have chosen a middle path. We limit our examination to the two most vital sub-sectors of activity from a borrower and investor standpoint: banking and securities markets. In our discussion of securities markets, we have incorporated elements that affect investment management. Likewise, we touch upon the increasing "assimilation" of the European insurance industry into a universal financial services conglomerate in our concluding discussion on the strategic implications of financial integration for participants in the European financial services industry.

While non-EEC European countries are not considered, recent regulatory changes and market developments in those countries indicate a large degree of "assimilation" and convergence into the overall transformation process that is occurring within the EEC.[1] Moreover, our analyses of the banking and securities markets sectors are made on a comparative *European level*. As such, specific country remarks are made only to clarify significant deviations from the European perspective.

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[1] Note in this respect that the various European Free Trade Area (EFTA) countries are increasingly concerned about being excluded from the large EEC market on the basis of having different regulations and standards; their self-induced "aligning process" should result, over the next five to ten years, in similar structures and systems in the financial sector.

The rest of this monograph is structured into six parts. Section II begins with a brief overview of the various historical and current elements that have come together in formulating and driving the notion of European financial integration. In Sections III and IV we individually consider each of the two sub-sectors, banking and securities markets. Relatively more emphasis is placed on the banking industry due not only to the importance and multi-faceted nature of this activity in Europe but also to the fact that the ongoing developments of this industry will profoundly affect every level of the European economy, from the individual consumer/investor to the largest pan-European corporation. Section V is an examination of the aims and implications of the main EEC directives that concern both the banking and securities sub-sectors. Section VI lays out, in the form of a series of hypotheses, various strategic implications of financial integration for the major participants (financial intermediaries, retail consumers, institutional investors, corporations, and governments) in the European financial sphere. Section VII contains concluding remarks.

II. The Forces Driving European Financial Integration

A popular view holds that the integration of European financial markets was simply "dictated" into existence by various legislative efforts of the European Commission in Brussels over the past three decades. Indeed, it was the 1957 Treaty of Rome which clearly stated the desire to create a customs union among the signatories, which for the financial sector meant freedom of establishment, of provision of services and of capital movements.[2] But this view strongly presumes that the transformation process in European financial markets has been following some neat timetable of actions and ignores divergent financial regulations and structures of individual markets which are hesitant in given up centuries of well-entrenched practices.

Historical realities of European financial integration show a rather different picture: one of fits and starts, of national political interests, or fears of economic domination by major powers providing obstacles. Numerous chicken-and-egg arguments were expounded: true financial integration cannot be realized unless monetary union is established first; monetary union is impossible without a convergence of national economic/monetary policies; national economic/monetary policies cannot converge without some form of political union. Each argument raised further debates and pushed behind the possibility of achieving any form of financial integration.[3]

Why did this rather bleak scenario change dramatically over the last decade? Four key interlinked reasons can explain this change:

1. Rising Economic Interdependence

As European cross-border trade, investment and capital flows increased, the need for greater harmonization of divergent national financial regulations became more evident.[4] Europe increasingly came to view itself as an "economic bloc" with a handicap: the state of economic and financial fragmentation was perceived to be a "cost" that lowered the productivity and economic efficiency of European businesses vis-à-vis players in the integrated markets of the U.S.A. and Japan.

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[2] For further analysis on the historical origins of the EEC see Steinherr and Gilibert (1989) and Commission of the European Communities (1988 a,b).

[3] A good review of the obstacles to European financial integration is presented in Fair and de Boissieu (1988).

[4] Trade among EEC members far surpasses trade with third countries (see IMF 1989); the 1992 directives should increase the absolute volume of these trade flows.

2. Fall-out From Global Financial Deregulation

U.S. and Japanese deregulation in financial services from the mid-1970s onward had a strong "ripple effect" on the major European financial centers, especially London. Fears of rising competition from American and Japanese institutions armed with skills gained in more liberal and competitive markets had the effect of promoting the calls for European deregulation. Although the U.K. led the process, other European countries quickly followed so as not to be left behind.[5]

3. Increasing Technological Progress and Applications

Technology affected the European financial sector two-fold. First, it enabled non-regulated firms to provide financial services at a lower cost than established firms (e.g., the OTC markets in securities or non-bank consumer credit firms). This phenomenon brought about competitive distortions which led, for all practical purposes, to effective deregulation. Similarly, as Llewellyn (1988) points out, the use of technology by securities firms in New York to service U.K. investors was a major factor undermining the self-imposed regulation of the London Stock Exchange.[6] Second, advancements in telecommunications and decision-support systems for trading, investing, and transaction data processing have had the tangible effect of integrating banking and securities markets across Europe.

4. Modification of the EEC Legislative Processes

The June 1985 publication of the White Paper on the creation of a unified European market greatly altered the past "consensus" approach that European commissioners took in the legislative area of financial integration. Instead of waiting for thousands of national regulations and practices to be harmonized perfectly, they opted for a "dynamic disequilibria" approach.[7] This fundamentally entailed three aspects which remain the guiding philosophy behind the current directives in the financial sector: harmonization of the most basic rules in the provision of financial services, mutual recognition of each Member country's supervisory criteria and home-country supervision of the foreign activities of financial institutions.

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[5] See Hawawini and Jacquillat (1990). Also, as Lewellyn (1988) rightly points out: "if the regulatory environment in other countries has the effect of conferring a competitive advantage on foreign institutions, pressure develops to adopt a similar regulatory arrangement. To the extent that technology has the effect of integrating financial systems, it also contributes to a trend towards developing similar regulatory arrangement between countries"; p. 252 in Fair and de Boissieu (1988).

[6] See Fair and de Boissieu (1988), p. 251-252.

While the first three factors had slowly gnawed away at the fringes of national regulations, the realization that the European Commission had an innovative and somewhat heretical deregulatory approach (and had even established a target date) galvanized the European financial services industry into somewhat bewildered action. As this transformation process accelerated, two questions were frequently raised: What are the potential benefits of financial integration? And can they be estimated in any tangible fashion?

Numerous academic and non-academic studies have been undertaken to answer the first question.[8] Basically, the benefits discussed can be summarized as follows: (1) an improvement of the allocative efficiency of savings and investments; (2) a pooling of national capital markets will lower the dependence on financial centers outside the EEC and hence reduce its shock-sensitivity to external economic developments[9]; (3) a reduction in the risks of capital investments through increased diversification opportunities (true for both investors and financial intermediaries); (4) the lowering of the cost of funding for borrowers as they diversify their sources of funds in an increasingly competitive financial environment; and (5) stronger (and potentially larger) financial institutions can be fostered to compete with global giants from the U.S. and Japan.

The second question was answered by the results of a study commissioned by the EEC, and executed by Price Waterhouse in 1988, to evaluate the opportunity cost of not having a financially integrated Europe. Table 1 presents the results in a summary form. The study covered various products within the banking, securities and insurance sub-sectors and involved only eight countries; in addition, several key methodological shortcomings have been identified.[10] Nevertheless, the study served a vital purpose as an illustrative example of the differences in prices for financial products/services across Europe.

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[7] The driving philosophy behind this was the Commission's view that "perfect harmonization of prudential measures would not necessarily have to precede the complete liberalization of capital movements and the freedom of cross-border supply of financial services, but would be a development somehow forced on member governments by the gradual movement towards an integrated market for financial services." Steinherr and Gilibert (1989), p. 7.

[8] See Rolf H. Hasse (1988) in Fair and de Boissieu (1988), pp. 291-308.

[9] The notion here is that an integrated Europe will be able to go from being a small entity with a passive role in influencing interest rates to a large entity with substantial weight in international capital flows and interest rates; Fair and de Boissieu (1988), p. 301.

Potential price reductions were indicated for all eight countries and in every sub-sector (with a range of 9 percent for the case of the Netherlands to 34 percent for the case of Spain). Adjusted for the possibility that the European markets may not soon become perfectly competitive and integrated, more realistic price reductions in the range of 4 percent to 21 percent were estimated as shown by the "indicative price reductions" row. Across all sub-sectors and on a country basis, Spain and Italy reveal the greatest potential for price reduction (34 percent and 29 percent, respectively) with the U.K. and the Netherlands proving to be already quite price competitive (with potential reductions of 13 percent and 9 percent, respectively).

The most revealing nature of these estimations, however, is not in the total figures for all financial services or even by sub-sector. Rather, they lie in examining each product line which reveals a checkerboard picture of efficiency across European financial services. For instance, relatively efficient Germany in private equity transactions seems to be leading Europe in inefficiency in consumer credit. Similarly, the U.K. is extremely efficient in institutional securities trading (due to thin pricing on large transactions made possible by large volumes traded) and life and motor insurance but is highly priced for private equity transactions or for home insurance and consumer credit.

Hence, from a retail or corporate consumer's standpoint, the benefits of an integrated Europe in financial services will be seen in different product categories, different sub-sectors, and different countries. The challenge for intermediaries will be to understand this checkerboard of opportunities, formulate strategies that capitalize on micro-skills, often at the product or functional level, and execute these differentiated strategies on a European-wide basis.

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[10] For instance, what is considered a "representative" sample of financial products will vary among countries; it is difficult to ensure price comparability for any given product; it is almost impossible to clearly identify the factors for price reductions (say, between the influence of EEC actions and the increasing processes of global deregulation).

TABLE 1
Estimated Price Reduction in Financial Products Resulting from Complete European Financial Integration

	Country							
	Bel.	Ger.	Spa.	Fra.	Ita.	Lux.	Neth.	U.K.
1. Percentage difference in prices of financial products compared with the average of the four lowest observations.[*]								
Banking								
Consumer credit	-41	136	39	105	—	-26	31	121
Credit cards	79	60	26	-30	89	-12	43	16
Mortgages	31	57	118	78	-4	—	-6	-20
Letters of credit	22	-10	59	-7	9	27	17	8
Foreign exchange	6	31	196	56	23	33	-46	16
Travellers cheques	35	-7	30	39	22	-7	33	-7
Commercial loans	-5	6	19	-7	9	6	43	46
Insurance								
Life	78	5	37	33	83	66	-9	-30
Home	-16	3	-4	39	81	57	17	90
Motor	30	15	100	9	148	77	-7	-17
Commercial fire, theft	-9	43	24	153	245	-15	-1	27
Public liability	13	47	60	117	77	9	-16	-7
Securities								
Private equity	36	7	65	-13	-3	7	114	123
Private gilts	14	90	217	21	-63	27	161	36
Institutional equity	26	69	153	-5	47	68	26	-47
Institutional gilts	284	-4	60	57	92	-36	21	—

Table continued on next page

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[*] Observations for consumer credit in Italy and mortgages in Luxembourg were not obtained, and are represented by mechanical estimates in the calculations of the larger aggregates. The data for institutional gilts transactions in the U.K. were not available on a comparable basis, and so the figures for institutional equity transactions were used in the calculations.

TABLE 1—continued

	Country							
	Bel.	Ger.	Spa.	Fra.	Ita.	Lux.	Neth.	U.K.
2. Theoretical potential price reductions[†]								
Banking	15	33	34	25	18	16	10	18
Insurance	31	10	32	24	51	37	1	4
Securities	52	11	44	23	33	9	18	12
Total	23	25	34	24	29	17	9	13
3. Indicative price reductions[‡]								
All Financial Services								
Range	6-16	5-15	16-26	7-17	9-19	3-13	0-9	2-12
Centre of range	11	10	21	12	14	8	4	7

[†] The figures in part 1 of the table show the extent to which financial product prices, in each country, are above a low reference level. Each of these price differences implies a theoretical potential price fall from existing price levels to the low reference level. Part 2 sets down the weighted averages of the theoretical potential falls for each sub-sector.

[‡] Indicative price falls are based upon a scaling down of the theoretical potential price reductions, taking into account roughly the extent to which perfectly competitive and integrated conditions will not be attained plus other information for each financial services sub-sector, such as gross margins and administrative costs as a proportion of total costs.

Source: Commission of the European Communities (1988a), p. 91, based on a study undertaken by Price Waterhouse.

III. European Banking: Integration Under Dynamic Disequilibria

That an integrated European banking system will be the lifeblood of an integrated European economy almost goes without saying. Yet today European banking is far from integrated. Neither is it fair to conclude that European banking structures and systems are stagnant and closed. In reality, as we shall discuss below, the European banking industry is in a complex state of turbulence.

Our observation of the market reveals that this somewhat "messy" state of affairs can be boiled down to three phases of change of which the current market structure and dynamics roughly corresponds to the second phase. These are: (1) pre-1975 phase in which traditional functions and client segments were closely followed by all banks; (2) the 1975-1992 phase which is witnessing the blurring of functions and some shake-out and consolidation at the *national* level; and (3) the 1992-and-beyond phase in which shake-out and consolidation at the *European* level should take place. We will touch upon these phases of change in our discussion below.

1. The Evolving Structure and Dynamics of the European Banking Sector

(a) *Comparative Market Sizes and Types of Institutions*

Two words may sum up a consolidated view of the European banking industry: diversity and fragmentation. As a result, European banking today is characterized by a rich mosaic of national institutions with different historical origins, functions, and corresponding structures. Yet, it is possible to form broad categories from this 'pot pourri' of institutions.

As shown in Table 2, in each country there are "commercial" banks (traditionally, deposit-taking for corporate lending), "savings" banks (traditionally, retail deposit-taking for general investments), and "specialized" banks serving a very focused client group (including municipal credit institutions, mutual and cooperative institutions, building societies and finance companies of all types). In terms of number, commercial banks represent approximately 21 percent of the total, savings banks 15 percent and specialized banks 64 percent.

TABLE 2
Number and Type of Banking Institutions in the EEC-12 Countries, 1988

Country	Commercial Banks	Savings Banks	Specialized* Banks	Total
Belgium	88	34	53	175
Denmark	79	147	18	244
France	386	422	1,272	2,080
Germany	311	596	3,636	4,543
Greece	35	0	9	44
Ireland	39	3	18	60
Italy	268	90	813	1,171
Luxembourg	115	1	86	202
Netherlands	85	65	26	176
Portugal	19	1	3	23
Spain	138	80	381	599
U.K.	588	0	162	750
Total	2,151	1,439	6,477	10,067

*Includes cooperative banks, special purpose banks, quasi-banks as licensed deposit-taking companies, finance and lending companies, etc.; does not include direct banking activities (e.g., non-licensed subsidiaries) of retailers or industrial companies.

Source: Own compilation based on direct contacts with OECD, individual central banks' research departments, and general literature review.

Three countries account for almost 90 percent of Europe's specialized banks: Germany (3,600 cooperative banks), France (over 1100 special "financial institutes") and Italy (over 800 cooperative banks). While the asset breakdown by category of banking institution is difficult to obtain, we estimate that in the four major countries (Germany, France, Italy and U.K.), approximately 62 percent, 65 percent, 70 percent and 90 percent, respectively, are controlled by both commercial and savings banks.[11]

These categories, however, should not be construed as being definitive functional or client segment divisions of activity. Within most

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[11] These estimations are based on individual central bank reports and OECD publications (1988, 1987a).

European countries over the past decade market dynamics have shown that, as one category after another exhausted its traditional product or client base, they entered each other's sphere of business.

For example, municipal credit banks in France, Germany, and Belgium were originally established by the local communes to finance local investments from medium- and long-term bonds issued under governmental guarantees. Over the past five years, as demand for local public investments has stabilized or even declined, these banks have aggressively pushed into corporate, consumer and mortgage lending to maintain profitability.

In addition, new non-financial entrants (such as retailers and captive finance companies of manufacturing firms) are rapidly penetrating traditional banking activities (such as deposit-taking and consumer lending) by either leveraging upon their superior cash-flow positions or by tapping the distribution potential of their client segments.

Similar instances of "blurrings of roles" can be cited within practically all areas of European banking, and more recently even certain areas of securities and insurance activities have been blended into the general sphere of banking. This erosion of traditional roles within national European banking markets has had the effect of changing the character of the state of fragmentation: instead of 10,000 European bank with broad traditional categories of specialization we currently are observing 10,000 banks all more or less beginning to engage in similar activities. As we shall see in our discussion of market concentration, *this current market structure is not viable, neither within country markets nor on an integrated European level.*

Taken on a consolidated basis, European banking activity measured in total assets (ECU 6.9 trillion) exceeds slightly that of Japan (ECU 6.2 trillion) and the U.S. (ECU 5.6 trillion). In Table 3, the European figure is broken down by EEC countries. Not surprisingly, the top four major economies, containing 70 percent of the Community's population and 81 percent of its GNP, also control 78 percent of the total banking assets. Similarly, in the next group of economies, Netherlands, Spain and Belgium, a clear relationship exists between GNP (15 percent of total EEC) and banking assets (15.7 percent of total EEC). The final 6 percent of banking assets is spread out among the five smaller nations with Luxembourg considerably ahead due to its role as a European banking center.

TABLE 3

Distribution of Total Number of Banks and Total Banking Assets by Country—1987

Country	Number of Banks	Total Assets (ECU billion)	Percentage of EEC-12
Germany	4,543	1,811.0	26.2
France	2,080	1,343.8	19.4
Italy	1,171	753,9	10.8
U.K.	750	1,515.7	21.8
	8,544	5,424.4	78.2
Netherlands	176	398.8	5.8
Spain	599	369.7	5.2
Belgium	175	315.2	4.6
	950	1,083.7	15.7
Denmark	244	99.2	1.4
Luxembourg	202	173.6	2.5
Greece	44	59.9	0.8
Portugal	23	48.7	0.7
Ireland	60	27.5	0.4
	573	408.9	6.1
Total EEC-12	10,067	6,917.0	100.0
U.S.A.	34,249	5,558.9	—
Japan	5561	6,270.3	—

Source: Compiled from various data sources based on own literature search; OECD, *Financial Accounts of OECD Countries* (1988, 1987).

(b) *Comparative Ownership Structures*

In comparison with the U.S. and Japan where state involvement in banking is generally limited to their respective central banks, governments play a major role in European banking. Table 4 provides an indicative ownership breakdown for the top 162 EEC banks.[12] Approximately 40 percent of the top 162 banks are central- or local-government controlled, another 16 percent are cooperatives and mutuals,

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[12] These 162 EEC banks are the top banks represented in a survey by *The Banker* (1988) of the world's top 500 banks.

TABLE 4
Ownership of the Largest EEC-12 Banks[*]

Sector	Number of Banks	Mean Assets (ECU bil.)	Pre-tax ROA[†] (%)	Pre-tax ROE[‡] (%)	Capital/ assets Ratio (%)
Public (central & local government)	67	26.9	0.61	14.30	3.70
Private	69	32.6	0.77	16.36	4.81
Cooperatives	14	35.9	0.89	17.31	5.16
Mutuals	12	9.0	0.81	14.78	6.14
Total	162				

[*] Data based on 162 EEC-12 banks in the "Top 500" survey undertaken by *The Banker*, July 1988; all figures are arithmetic means; sample data should be viewed as indicative due to the uncertainty of their statistical significance.

The country split for these 162 top EEC banks is as follows: Germany -44, Italy-33, France -20, U.K. -15, Spain -13, Belgium -9, Denmark -8, Luxembourg -6, Netherlands -5, Portugal -4, Greece -3, and Ireland -2.

[†] ROA = Return on Assets

[‡] ROE = Return on Equity

Source: The Banker, January 1989, p. 39.

leaving 44 percent in the hands of private independent shareholders. Among the top four countries, the U.K. banking sector is most "private," whereas in France and Italy government ownership is paramount among the top commercial banks and in Germany the relatively powerful regional Landesbanken are owned by the local state governments.

In terms of their comparative financial positions, European state-owned banks are somewhat smaller in asset size (mean size of ECU 27 billion versus 33 and 36 billion for private and cooperatives), are less profitable (both on ROA and ROE measures) and are less well capitalized (based on capital to assets ratios).

Two key implications can be drawn from this ownership profile of the European banking sector. One, large government-owned banks will find it increasingly harder to compete with private and cooperative banks of the same size league. Their capital position is already low and raising new funds for significant acquisitions or higher risk banking activity requiring higher capital will be difficult at best.[13] The pressure to de-nationalize and to publicly float these giant banks in France and Italy hence may become stronger, both from within the bank's management and from cash-strapped governments. Two, co-operatives and mutuals, by their very closed-share ownership structure will be unlikely candidates for acquisition; indeed some are large enough to be acquirors of medium-sized private banks. Relatedly, in the years ahead we should be witnessing more strategic alliances between private banks and cooperatives and mutuals that wish to maintain their legal independence.

(c) *Branch Density and Industry Profitability*

The European banking sector is characterized by an extremely dense branch network in the more developed economies. This is shown in Figure 1. Per capita gross domestic product (GDP) increases as we move away from the origin on the horizontal axis. Branch density (measured by the number of inhabitants per bank branch) decreases as we move away from the origin on the vertical axis. A look at Figure 1 shows that, except for the case of Spain,[14] there is a negative relationship between increasing per capita GDP and decreasing branch density. In other words, countries with higher income per capita tends to support a higher number of bank branches per inhabitants.

Similarly, in those countries characterized by high bank intermediation spreads, the branch density appears to be higher. This is shown in Figure 2. Bank intermediation spreads (measured by interest-rate spreads expressed as a percentage) increases as we move away from the origin on the horizontal axis. And, as in Figure 1, branch density decreases as we move away form the origin on the vertical axis. Here again, the relationship is negative, between increasing bank intermediation spreads and decreasing branch density. This relationship would therefore imply that in those countries where banks can avail themselves of higher intermediation spreads for their services (for whatever reason, as we shall see below), there is a tendency for branch proliferation.

In addition to per capita GDP and bank intermediation

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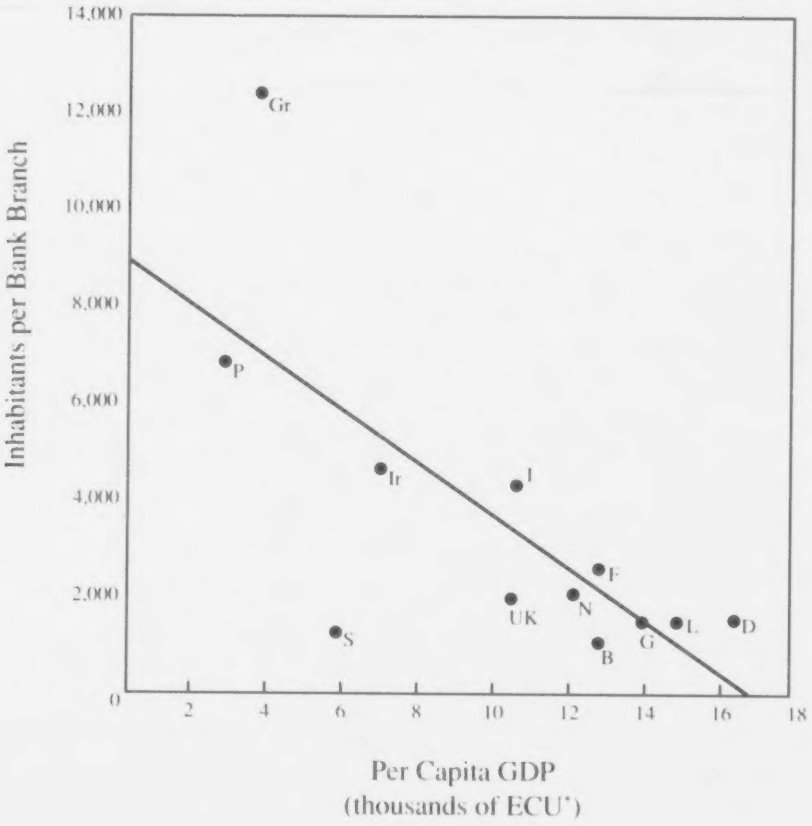
[13] For a discussion on the EEC proposals for capital requirements of the European banking sector, see Bernd Rudolph (1989) who touches upon this topic in discussing the capital requirements of German banks.

[14] See *Moniteur du Commerce International* (1988), p. 33. The fact that Spain has a high branch density despite a low GDP per capita has been explained by inefficiency in the Spanish retail banking sector where higher operating costs were passed on to borrowers.

FIGURE 1

Per Capita GDP/Banking Client Population



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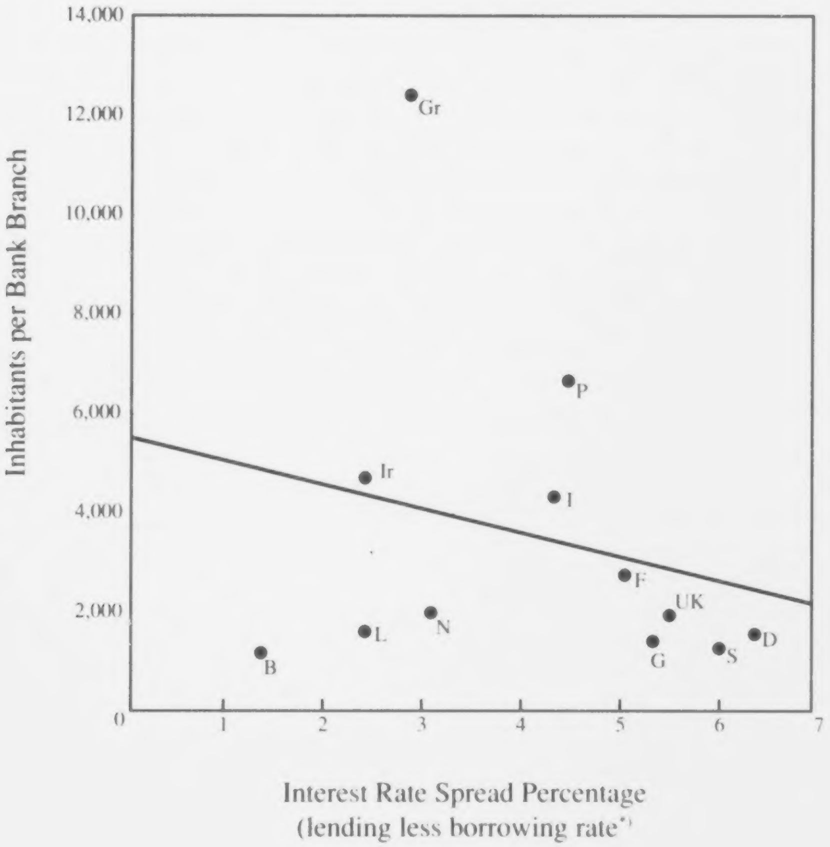
*Data consist of averages for 1985–1987 converted at mid-1988 exchange rates. B = Belgium; D = Denmark; F = France; G = Germany; Gr = Greece; Ir = Ireland; I = Italy; L = Luxembourg; N = Netherlands; P = Portugal; S = Spain; UK = United Kingdom.

Source: European Investment Bank EIB Papers, No. 7 (December 1988).

FIGURE 2

Interest Rate Spread / Banking Client Population



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*Data as of April 1988. Prime or base lending rates less interest rates paid on savings deposits or on small denomination savings certificates having a maturity of one year; minimum lending rates on overdrafts and bank advances, respectively, for the UK and the Netherlands. B = Belgium; D = Denmark; F = France; G = Germany; Gr = Greece; Ir = Ireland; I = Italy; L = Luxembourg; N = Netherlands; P = Portugal; S = Spain; UK = United Kingdom.

Source: European Investment Bank EIB Papers, No. 7 (December 1988).

spreads, a number of other factors can be drawn upon to explain differences in branch density among the twelve EEC countries, including: (1) varying government regulations on the opening of new branches; (2) inefficiency of the retail banking sector, the costs of which are generally not understood by the banks themselves and usually passed on to clients; (3) the level of sophistication and development of disintermediation in the country (e.g., direct mail mutual funds); (4) the retail activities of other non-bank financial institutions (who themselves may have a vast branch system); and (5) the level of development of non-traditional means of client relationship maintenance (e.g., ATMs, direct mail, or home banking).

In broad terms, it can be expected that in the higher density countries, increased competition resulting from financial integration will lead to a greater interest among the banks in undertaking branch profitability analyses. In turn, and in certain inefficient markets, such knowledge will be used to assess the necessity for branch rationalization. In others, this understanding will enable top managers of these banks to better evaluate the macroeconomic effects of the above factors so that the activities of the entire branch network may be restructured to capture "micro-marketing" characteristics of different local marketing zones within the country.

Two interesting implications may be hypothesized for the currently low density countries. While the first relationship discussed above would indicate that increasing economic wealth should increase branch density, one could argue that in an integrated European financial area, the effect of the above factors, especially the fifth factor, would negate any "natural" trend toward increased number of banking outlets. In the second relationship, the horizontal factor of higher bank intermediation spreads evident in countries such as France, Germany, U.K., and Italy could be viewed as being excessive economic rents which may be competed and regulated away in the post-1992 era. As such, it could be argued that as competitive conditions "equilibrate" across the EEC, the current low-density countries may not count upon the development and/or continuation of this factor to warrant increased branch proliferation.

The profitability of European banking varies greatly by country as revealed by Table 5. Three markets appear to be most profitable on an inflation-adjusted return on assets (ROA) and return on equity (ROE) bases: the U.K., Germany and Netherlands. On the other extreme, the high inflation in Greece, Portugal and Spain more than destroys the moderate levels of nominal ROE. As with branch density, one must draw implications with care. For example, any "blanket" application of ROA or ROE may neither indicate banking efficiency nor

TABLE 5

Measurements of Bank Profitability in EEC-12 Countries*

	Rate of Return on Equity (Before Tax)	Rate of Return on Assets (Before Tax)	Average Rate of Inflation
Belgium	14.25	0.39	4.87
Denmark	10.83	1.07	5.20
France	12.93	0.33	5.83
Germany	19.06	0.72	2.27
Greece	14.61	0.40	19.60
Ireland	12.84	1.08	6.27
Italy	19.27	1.09	9.53
Luxembourg	9.06	0.32	6.10
Netherlands	17.12	0.67	1.60
Portugal	5.06	0.33	21.67
Spain	9.95	0.83	10.60
United Kingdom	22.78	1.15	4.70

*Figures in percentages. Averages for the period 1984-1986. The inflation rate has been approximated with the GDP deflator at market prices.

Source: *OECD*, Financial Statements of Banks 1982-86.

the attractiveness of the sector from investors' standpoint. Differing accounting, tax, and regulatory practices from country to country make these comparisons difficult. For instance, while Spain has a relatively low ROE of 10 percent, the Spanish banks tend to leave higher provisions for bad debt and have higher capitalizations. German banks on the other hand tend to be more highly leveraged (if one excludes the hidden reserves) and hence have higher reported ROE.[15]

Additionally, certain markets which show low ROA figures may still be attractive for new entrants if they are, for example, able to improve the product "business system." In fact, the very process of European financial integration should result in a gradual arbitraging away of these wide differences in profitability measures. Furthermore, expected convergence of accounting standards should enable more valid comparison of these figures.

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[15] See OECD (1988a).

(d) *Market Concentration*

On a consolidated basis, the European banking sector lies between the U.S. and Japan in terms of market concentration. As Table 6 indicates, the top 3 European banks (Credit Agricole, Banque Nationale de Paris and Deutsche Bank) control 8 percent of the entire sector's assets with comparable figures of 7 percent for the U.S. and 12 percent for Japan. These generally low concentration levels vis-à-vis the Japanese and individual EEC country markets, may be considered normal in light of the fragmentation of the banking market at the national level. Similarly, in the U.S., the prohibition of interstate banking and even limitations to the level of unit banking have kept a "forced lid" on the size of any given bank with consequent low concentration ratios; conversely, nationwide banking ha. produced the higher concentration ratios in Japan.

While the concentration ratios are low on an EEC level, they are indeed higher on the national level; this is especially true among the smaller European economies as indicated in Table 7. For instance, the top 3 banks in Belgium, Denmark, Greece, Netherlands and Portugal control anywhere from 42 percent to 62 percent of their respective

TABLE 6
Market Concentration in the EEC Banking Industry*
(Assets in ECU Billons)

Category of Banks (1)	Total Assets of Category (2)	As % of Total Assets of EEC-12 Banking Sector (3)	Equivalent of (3) for the U.S. Market
Top 3	566	8	7
Top 5	899	13	10
Top 10	1,561	22	15
Top 20	2,430	35	21
Total EEC-12	6,917	100	

*Assumes an "integrated" view of the European banking sector

Source: The Banker, July 1988; OECD *Financial Accounts of OECD countries* (1988, 1987); own calculations.

TABLE 7

Market Concentration and Capitalization of Top 3 and Top 5 Banks in EEC-12 Countries
(Assets and Capital in ECU Billions)

	Top 3 Banks			Top 5 Banks		
	Assets	% of Total	Capital	Assets	% of Total	Capital
Belgium	132.6	42.1	2.6	199.3	63.3	4.4
Denmark	49.5	50.0	3.2	78.8	79.4	4.4
France	489.9	36.5	16.5	721.5	53.7	22.9
Germany	347.1	19.2	12.4	512.4	28.3	16.6
Greece	37.4	62.4	0.8	NA	NA	NA
Ireland	NA	NA	NA	NA	NA	NA
Italy	205.1	27.2	8.6	310.7	41.2	12.4
Luxembourg	34.0	19.6	1.4	48.9	28.2	1.8
Netherlands	214.6	53.8	9.4	280.6	70.4	11.6
Portugal	25.0	51.0	0.9	33.2	68.1	1.2
Spain	116.0	31.4	6.4	165.9	44.9	9.8
U.K.	362.1	23.9	23.1	483.2	31.9	28.2

Source: *The Banker*, July 1988; OECD *Financial Statistics* (1988, 1987); own calculations.

country's banking assets. Luxembourg is a notable exception due to the presence of a large number of foreign banks. Among the major four countries, only France has a relatively high concentration ratio (37 percent for the top 3 banks). Observing the spate of merger and acquisition activities in the last half of the 1980s may allow one to draw the following implication of these current national and EEC-level concentration ratios. The integration process is most likely to initially further increase *national* concentration ratios, especially in large and less developed banking markets, as major local banks strive to protect home markets. Only after a certain period of acquisition "digestion" and observation of the developments of a unified financial market will we see concentration ratios increasing at the EEC level. Until that period, preemptive strategic alliances made in the next few years will be the main form of guarding future options.

(e) *Economies of Scale/Scope and Bank Mergers*

Interpreting these branch density, profitability and market concentration ratios raises the vital question of whether there are economies of scale and scope to be captured as the European banking sector integrates. Several key studies have been undertaken on the question of economies of scale in financial services with a mostly U.S. background.[16]

Most of these studies focus on the more traditional areas of banking activity such as deposit-taking and lending than the more technology-based product areas such as credit card business or cash management. The fundamental issue underlying all these analyses is whether there are operational advantages to be gained from product-type proliferation and product-volume expansion in banking which can be assessed independently of the quality of any given bank's management.

The general conclusion appears to be that, on average, economies of scale in banking are at best elusive, limited, and seem to be exhausted at a fairly low size of bank.[17] In other words, a bank that is moderate in size should not be at a significant cost disadvantage relative to a large bank.[18] Economies of scope have often been used to justify diversification of banking activities but in the U.S., diversified banks neither seem to be more stable nor more profitable than those banks limited in scope of activity. In fact, diseconomies of scope may even exist.[18]

It is doubtful that current European banking structures are conducive to economies of scale or scope. In some ways, with Europe's highly differentiated financial and cultural markets, diseconomies of scale and scope may serve as arguments *against* increasing assets and diversifying across activities. In fact, size does not appear to be a prerequisite for profitability. Table 8 summarizes the results of a study done by Steinherr and Gilibert (1989) of the correlation between asset size and profitability for the largest banks of each of the EEC countries. They

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[16] For further analysis of economies of scale and scope in banking, see Clark (1988), Revell (1989), Dermine, editor (1990), Steinherr and Gilibert (1989), Federal Reserve Bank of Atlanta (1982), and Benston (1965).

[17] See Revell (1989), p. 185 and Steinherr and Gilibert (1989), p. 53.

[18] Nevertheless, without further empirical evidence to prove the contrary, it is altogether possible that significant economies of scale or scope may exist in those non-traditional banking activities that efficiently leverage any inherent technology potential.

[19] Note in this regard the difficulty faced by most banks in managing proliferating product lines at a time when product complexity is also increasing.

TABLE 8

Size and Profitability Comparisons for Banks in EEC Countries

	Profitability ranked by asset size*															Spearman Correlation Index
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
Belgium	4	9	5	3	8	7	1	6	2							-0.0546
Denmark	1	7	6	4	3	8	2	5								0.0151
France	8	7	3	6	2	10	5	4	13	11	1	14	15	12	8	0.0340
Germany	1	3	3	10	5	6	2	9	10	12	8	7				0.0478
Greece	3	2	1													-1.0000
Ireland	2	4	3	1												-0.3205
Italy	12	6	4	11	13	14	2	15	9	1	8	10	5	7	3	-0.0284
Luxembourg	1	5	3	4	2	6										0.0962
Netherlands	3	1	4	5	2											0.1667
Portugal	1	4	2	3												0.4006
Spain	3	4	13	7	5	12	11	1	9	8	2	6	10			0.0036
U.K.	7	5	10	8	9	3	1	2	6	4						-0.0823

*Profitability (inside figures) is measured by pre-tax profit on total assets; size (top layer of figures) is measured by total assets (total deposits for Italy); data is as of 12/31/87. For example, in the case of Greece (with only 3 banks in the sample) the bank with the highest size (rank 1) has the lowest profitability (rank 3); the bank with the second highest size (rank 2) ranks second in profitability (rank 2) and the bank with the smallest size (rank 3) has the highest profitability (rank 1).

Source: Centre For European Policy Studies, Research Report No 1, January 1989, Tables 5a and 5b.

conclude: "the correlation between size and profitability is either negative or, at best, a very tenuous one."[20]

These studies do not mean, however, that European banks should not (or will not) merge. It simply means that they should not blindly point to economies of scale and scope as their sole justification and wait for profitability improvements. Other reasons may justify future European bank mergers and acquisitions.

For example, Steinherr and Gilibert (1989) distinguish between mergers/acquisitions *within* one country that enables operations streamlining and rationalization of, say, the number of branches, and cross-border mergers of banks where these efficiencies and synergies are more difficult to capture.[21] Their comments are corroborated by recent evidence provided by Hawawini and Swary (1990) on the differential stock market reaction to takeover announcements that concern intrastate and interstate cases. The results indicate that "the market reacts to the announcements of *interstate* mergers less favorably than to the announcements of *intrastate* mergers and that the differential market reaction is stronger for bidding banks than for target banks."[22]

Finally, Revell (1989) discusses two other viable explanations for the growth of larger banks: the need to be able to effectively serve large customers and the need to match the growing size of foreign banks.[23] These justifications will need to be empirically tested as to whether they will result in more competitive (than just large) banks.

(f) *Specialized Banks Versus Universal Banks*

A related question to the one of economies of scale/scope is that of whether universal banking will become the norm in an integrated Europe. As we will see in the fifth section, the EEC's Second Banking Directive will, in essence, enable universal banking across Europe. Already, unlike the U.S. and Japan, "restrictions on security underwriting are virtually non-existent in European countries in a great majority of which securities business is regarded as an integral element in commercial banking."[24] And theoretically, after 1992, banks will be allowed to own shares of non-financial corporations (within some limits); now only Germany, Luxembourg, Spain and the U.K. have no specific restrictions.[25]

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[20] See Steinherr and Gilibert (1989), p. 55. Since we do not know the statistical significance of these correlation coefficients (i.e., are they statistically different from zero at, say, the 5 percent significance level), we should interpret these numbers with some measure of caution.

[21] Op. cit., p. 53.

[22] See Hawawini and Swary (1990).

[23] See Revell (1989), p. 186.

[24] See OECD (1987b), p. 58-59.

The verdict is still out on whether universal banking is the ultimate natural development in the provision of financial services. Some bank strategists have argued that "one-stop banking" is what clients in a future integrated Europe will desire; others have undertaken market surveys to point to a growing sophistication among buyers of financial products with a trend toward shopping around for the optimal price/value formula. Steinherr and Gilibert (1989) discuss numerous pros and cons for universal banking and conclude in the middle: "in an integrated European market it seems safe to expect a proliferation of both specialized and universal banking structures."[26]

Nevertheless, one can argue further that while both forms may proliferate, current trends in corporate finance, internationally, seem to indicate that each type is better suited to serve different needs of end-client markets. For example, while proponents of one-stop universal banks argue that their asset size, vast networks and range of product offering allows them to more effectively focus on the needs of large multinationals and high net-worth individuals, it is these very client categories that tend to take a specialized attitude to borrowing and investing, keeping for themselves the task of putting the "final package" together. This would then imply, ironically, that the value proposition of universal banks may be more attractive to the mass client and to the small to medium corporate market, both segments that neither have the time nor expertise to benefit from piecing together a borrowing or investment package.

(g) *Degree of Internationalization of National Banking Markets*

One way of assessing how much further European banking markets need to travel toward financial integration is to observe the current "degree of openness" of the various EEC-12 countries. Table 9 presents two measures of "foreign" banking activities; unfortunately, breakdowns for inter-EEC banking activity alone was unavailable. Measure 1 estimates the control of total banking assets by foreign banks in the host country. Luxembourg with 91 percent, U.K. with 60 percent and Belgium with 46 percent are most receptive to foreign banking presence.

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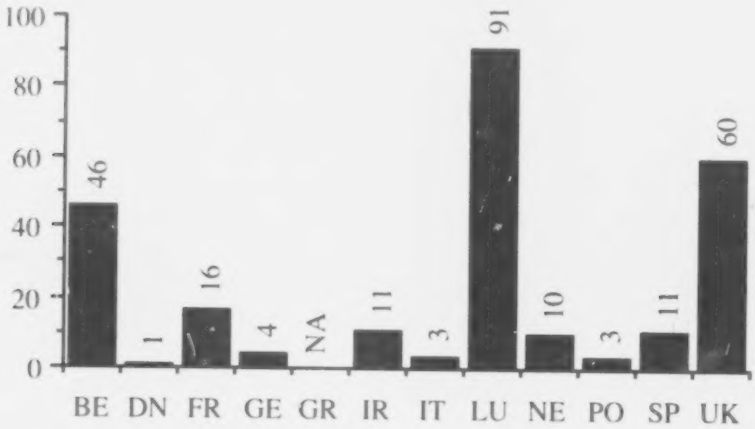
[25] Op. cit., p. 60.

[26] See Steinherr and Gilibert (1989), p. 34.

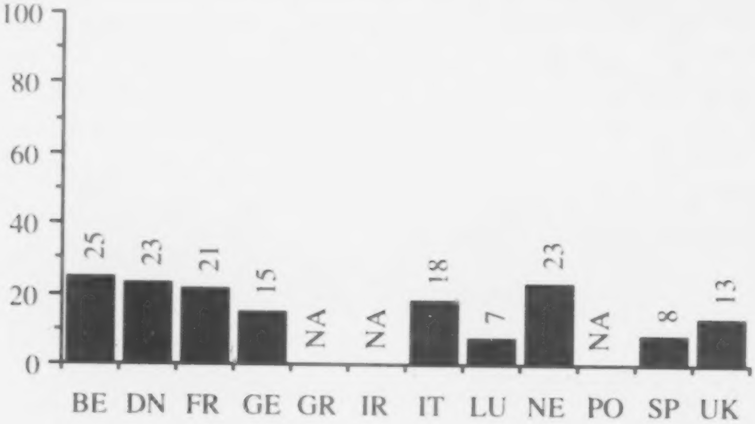
TABLE 9

Estimations of the Degree of Internationalization
of EEC-12 Countries' Banking Sector
(End of 1987; figures in % of total banking assets)

Measure 1[*]



Measure 2[†]



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[*] Percent of total banking assets held by foreign financial institutions; end 1986 for Ireland.

[†] International business of domestic banks as a percent of total banking assets ("international business" = foreign and domestic currency claims on non-residents and foreign currency claims on residents); end 1986 for Belgium for total assets figure.

NA = Not available.

Sources: Centre for European Policy Studies, Research Report No. 1, January 1989; OECD, Financial Accounts at the OECD Countries (1988, 1987); own calculations.

But caution in interpretation is warranted here: these figures do not mean that foreign banks have successfully penetrated the local retail and corporate banking markets. In the case of Belgium, favorable tax incentives to encourage the use of Brussels as a financial "service center," coupled with efficient inter-bank settlement systems, have resulted in foreign banks (especially the Japanese) booking and trading vast portfolios of money market assets (as bank CDs or liquid inter-banks funds) and longer term debt paper. The U.K., based on its importance as a world financial center with an extremely high concentration of banks, is now the de-facto origination and booking center for international syndicated loans and Eurobonds. And Luxembourg, which has built its economic mainstay on attracting and maintaining foreign financial institutions is now a key center for private banking which is enhanced by its reputation as a tax haven for booking individual securities portfolios.

Measure 2 estimates "international" activity of domestic banks (as measured by the share of total assets in the form of foreign and domestic currency claims on non-residents and foreign currency claims on residents). As such it answers the following question: "of the same total recorded banking assets as in Measure 1 above, what share can be attributed to the international business of the country's domestic banks?" Here Belgium leads with 25 percent, followed closely by Netherlands and Denmark (both 23 percent) and France (21 percent). Germany, Italy, the U.K. and Spain all have less than 20 percent. In comparing Measures 1 and 2, it is interesting to note that the importance of the foreign presence for the U.K. and Luxembourg banking sectors vis-à-vis their own international activity; not surprisingly, these two countries have been most defensive of any EEC legislation that would jeopardize London or Luxembourg as international centers of finance.[27]

(h) *Buyers, Suppliers, and Intermediaries in the European Banking Industry: Shifts in Relative Power*

Up to roughly the beginning of the second phase of change (1975) discussed earlier in this section, the European banking industry could have counted on a somewhat "captive" and rather passive group of retail depositors on one hand and retail/corporate borrowers on the other.

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[27] Note in this regard the U.K.'s constant reference to the strong opposition from U.S. banks that have threatened to reciprocate against any EEC action that would hamper their European activities, especially in London; similarly, Luxembourg has not been enthusiastic about measures for harmonizing withholding tax differences among member states (by agreeing to a fixed withholding level of, say, 15 percent) as it would diminish its attractiveness as a tax haven.

The first group had few investment options as deposits were paid little or no interest and retail mutual funds were still a rarity. The second group was relatively ignored by most banks who did not understand individual and middle and small-market corporate risk assessment and hence ended up charging excessive lending spreads.

Various deregulatory and market factors converged in most industrial countries in the early 1980s to start off a chain of reactive changes among banks and these two "client" groups. On the liability side, the rise of money market mutual funds and deposit interest rate deregulation increased funding volatility and costs for the banks but at the same time opened new avenues of retail investment opportunities. Simultaneously, on the lending side, banks were finding that their large corporate clients were increasingly tapping international capital markets thereby directly diminishing the role of banks as financial intermediaries.

As profit margins in these once stable businesses declined, banks rapidly turned their attention to those client segments that they had once ignored: consumer borrowers and small and middle-market companies. As nearly all the large European banks have begun to serve the needs of these groups, competition for their business rose and consequently fueled the financial capacities of these groups for discerning the best providers, in terms of price/values of various products/services.

In many ways this current situation in Europe is similar to that which has prevailed in the U.S. over the last decade: the rate of financial disintermediation has outpaced that of banking sector deregulation. However, it differs in one notable respect. In the U.S., the banks have reacted to this predicament by unilaterally pushing for *de facto* deregulation by taking actions (as entering unauthorized lines of activities) that later tend to be approved *de jure*, in some form or another, by the regulatory authorities. In Europe, while the financial disintermediation process described above is taking place, the ability of the institutions in the industry to react to this process has been in some ways limited in pace to the rate of deregulatory legislation from the Commission in Brussels.

The practical implication of this "deregulation lag" has been a dramatic shift in relative power of the various market participants in European banking: buyers and suppliers of the banking sector now hold the weapon of "product substitution" and banks, faced with this prospect have had no other recourse but to look for internal improvements in operational efficiency and for a sharper strategic mind in assessing the external market for their services.

2. Summary

It is only partially fair to state that the character of European banking industry reflects the level of economic advancement of various individual nations. But that only accounts for the size aspect and does not express the "personality" of each country's banking system. For that aspect, we have to look to differing roles of the government sector, national attitudes to concentration of economic power in any one sector, traditional patterns of consumer savings and the degree of openness toward foreigners. All these characteristics reveal a complex mosaic of banking institutions, regulations and consumer attitudes that defy generalizations.

Moreover, European banking over the past decade has undergone tremendous positive change: markets are deregulating, retail and corporate clients are becoming more sophisticated and are demanding more "choice," and financial institutions are all entering each other's traditional core business attempting to improve on the other's business system.

Without the "integration mandate" of the European Commission, the smaller European markets may have contented themselves with past structures and systems; 1992 has galvanized even them into changing, often at double speed in order to catch up with the more developed financial and industrial markets. The picture of European banking markets then, is not one of stagnation, but of development and greater cohesiveness stemming from various elements of change.

IV. European Securities Markets: Building Linkages for Portfolio Diversification and Corporate Growth

With the notable exception of the U.K., European securities markets appear historically to have assumed a secondary role in private sector financing vis-à-vis the banking markets. Bank intermediation provided not only long term funds for corporate growth, but also fed the seemingly insatiable borrowing needs of the omnipresent central and local governments. In many countries even institutional funds were, by legislation, forcefully channeled into the holding of government paper. Not surprisingly then, European corporate bond and equity markets remained rather emaciated and country bound.

As we broadly discussed in the introduction, it was not simply the calls for 1992 that woke these dull markets and stirred them into action. Rather, until the middle 1980s, two factors of change were already acting on European securities markets: (1) technology and telecommunications advances and, (2) competition among key European financial centers in building a role as the European "link" in the increasingly global issuance and trading of securities. Then, from the middle 1980s onwards, an additional and indeed equally vital change factor emerged in the form of EEC initiatives in creating an integrated securities market by year-end 1992.

As we shall discuss below, while European securities industry is far from integrated, the upper end of the equity markets (e.g., large corporate) is already well on the way to integration. This phenomenon is characterized by consolidation of activity in major European financial centers. We shall also see that the very competitive struggle among the major centers for market share, coupled with the EEC efforts of harmonization/standardization of regulations, should lead to positive benefits for middle to small-size corporations and significant portfolio diversification opportunities for investors. As the literature on the Eurobond market is both vast and its pan-European and international scale and scope extremely well documented,[28] our main assessment here shall be of major European domestic bond and equity markets.

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[28] For a synthesis of the structure and dynamics of the Eurobond market, see Walter and Smith (1990).

1. Evolving Structure and Dynamics of European Securities Markets

(a) *Government and Corporate Bond Markets: Basic Profile*

Market sizes and types. As shown in Table 10, European domestic bond markets are different in scale and scope. Seven major national bond markets exist in Europe and in terms of comparative size of outstanding issues are approximately 60 percent of the U.S. market and 120 percent of the Japanese market. The four major countries account for 80 percent of the total outstandings and Germany alone accounts for 32 percent.

Except for Germany, the government sector (both central and local) is paramount in European bond markets accounting for, on average for the seven markets, 50 percent of the outstanding bond issues of all types [the comparable figures are higher in the U.S. (74 percent) and Japan (68 percent)]. However, in four countries, Italy, France, the U.K. and Belgium, the government share is approximately 80 percent. In the case of Germany (as well as in France), it should be noted that most of the non-government bond paper is primarily issued by financial institutions with "true" corporate bonds gravitating toward the Eurobond market.[29]

International bonds (Eurobonds and foreign bonds) exceed the purely domestic non-government issuer bond markets only in the U.K. where it is almost three times larger. It should also be noted that the private placement market for long-term paper is significant in both Germany and the Netherlands (and probably in some of the other EEC countries where market data is totally unpublished). And considering the traditionally strong role of commercial banks in European corporate financing, it is likely that much of the long-term borrowing needs of fairly large middle market companies (which in the U.S. could go the bond issuance route underwritten by small regional investment banks) is being met by private placements.

Despite the recent efforts of some U.S. investment banks to introduce the technique, the European bond markets do not have a distinct high-yield or "junk-bond" category, either of new issuance or of the "fallen angels" variety. This had frequently been attributed to investor preferences for capital preservation and anonymity rather than

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[29] See Salomon Brothers (1987a); the German financial institutions utilize their bond funding for on-lending to, or to purchasing shares in, German corporations.

TABLE 10

Major Europe Bond Markets: Size and Type of Issuer (Year-end 1987)

Bond Market	Total Publicly Issued[1] ECU Billions	Gov't Sector Issues:[2] as % of Total Issues	as % of GNP	Corporate and Other Domestic[3] Public Issues (Total Issues)	Int'l Bonds[4] as % of Total Issues	Private Placements[5] ECU Billions
Deutschemark	703.2	30.8	22.2	56.4	12.8	284.6
Italian Lira	468.0	81.5	58.5	17.9	0.6	-
French Franc	292.9	77.8	29.9	18.6	3.6	-
U.K. Sterling	288.3	77.8	38.4	5.8	16.4	-
Belgian Franc	170.5	80.0	111.0	17.6	2.4	-
Danish Krone	148.4	29.1	51.2	68.9	2.0	-
Dutch Guilder	111.3	63.2	38.0	23.2	13.6	79.9
Total major European Markets	2,182.6					
U.S.A.	3,609.8	73.6	67.9	16.2	10.2	316.1
Japan	1,837.1	68.1	60.6	26.9	5.0	300.6

[1] Nominal value outstanding

[2] GNP figures for 1987

[3] Corporate bonds include convertibles

[4] International bonds include both foreign bonds and Eurobonds (straight, convertible and floating rate debt)

[5] Private placements are unclassified issues; in addition there exists an unspecifiable amount of unreported paper in the private market

Source: Salomon Brothers, "Bond Market Research", May 20, 1988, p.1; GNP data from IMF (1989 March); own calculations.

for short-term high-risk/return portfolio strategies.[30] In addition to this reason, we observe that European investment banks are poorly capitalized and act more as brokers and hence have neither the capital nor the legal right to undertake mammoth bridge financing to hold the paper before off-loading on the markets (assuming that investors *were* receptive). The U.K. could prove to be an exception to this as revealed by the recent efforts of introducing high risk mutual funds for the leveraged buyout (LBO) market.

Growth prospects for corporate bond markets. Table 11 indicates the size of new issuance of corporate bond paper of all European companies over the 1985-1987 period. Again domestic bonds accounted from approximately 70 percent to 80 percent of all issues with growth in the total issuance size noted for each of the three years. The interesting question of whether European domestic corporate bond markets will continue to expand is also a complex one. Walter and Smith (1990) argue that the traditional reliance on banks is appearing to diminish due partly to the growth of Euromarkets and the growing familiarity of corporations with capital markets.[31]

While that is indeed true, several other key driving factors should also be assessed: the crowding out effect of government bond issuance, the ability of banks to become more efficient intermediaries and the possibility for banks to hold and trade securities after 1992, the relative importance of the Eurobond market with its attractive anonymity feature, the trend toward leveraged financing and mergers and acquisitions, and future portfolio mixes of Europe's growing institutional funds. These factors are briefly examined below.

As we saw in Table 10, government bonds today occupy a significant position in national bonds markets. There are few reasons to believe that this share will diminish over the next ten years: tax levels are typically already high in Europe and the EEC efforts at harmonization of tax standards generally has tended to go for the lower common denominator.[32] On the other hand, future freedom for capital movement and the ability to move financial activities anywhere will make it more difficult for governments to hand twist institutional investors (such as requiring certain percentages of pension funds to be kept in government bonds or

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[30] See Corrigan (1989).

[31] See Chapter on European investment banking by I. Walter and R. Smith in Dermine, editor (1990).

[32] Note in this respect that current efforts of the EEC in harmonizing value-added taxes and interest income withholding taxes where notions of tax "liberalization" has tended to push the final Europe-wide rates toward the lower end of any "average" measure that is utilized.

TABLE 11

Bond Market Financing by All European Companies
1985–1987 (in ECU millions*)

	Total Debt Issues			
	Eurobonds Bonds	Foreign Bonds	Domestic Bonds	Total Bonds
1985				
Number of issues	340	93		
Volume	29,106	3,014	95,695	127,815
1986				
Number of issues	449	95		
Volume	42,864	3,970	123,491	170,325
1987				
Number of issues	337	165		
Volume	25,337	5,602	143,713	174,652

*Converted from U.S.$ at year-end 1987 exchange rate.
Source: Securities Data Company (Euro and foreign data); OECD (domestic data)

limiting bond auctions to local players who then are forced to bid for the output). Governments will then, theoretically, be on equal footing for capital funding with domestic corporations; if this were to happen we can expect upward pressures on borrowing rates in those countries where the government debt as a percentage of GNP is already high (see Table 10).[33]

As we discussed in the section on banking, EEC legislation in that sector should create more competition at national and European levels and hopefully result in efficient producers (i.e., lower borrowing costs for corporate and retail consumers). One possible implication is that banks will try harder to keep core corporate clients: offering ample low-cost long-term capital which they then may try to off-load through asset sales. On the other hand, 1992 will also enable them to underwrite, hold and trade securities. Realizing that the returns are typically higher than on their government bond portfolios, coupled with the facts that they have a close knowledge of the credit risks involved and that liquid corporate bonds are useful for asset and liability management, may push banks into underwriting bonds instead of equity.

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[33] Interestingly, this competitive situation has been apparent in the U.S. over the past decade and in part has been offered as an explanation of the high U.S. interest rates.

The Eurobond market remains a large and the single most important unified corporate bond market (see Tables 10 and 11). Its peculiar attractiveness in the past was the anonymity it provided retail investors from national tax authorities; consequently the borrowing costs were often lower for corporations than if they issued in national bond markets. Walter and Smith (1990) offer several reasons for the continuing importance of this market.[34] But they add that post 1992 may see a "blending" of the Euro and domestic bond markets as the tax and regulatory differences will be harmonized away. It remains to be seen whether the recent proposal on a percentage interest income withholding (at the source) which specifically *excluded* Eurobonds, may not result in favoring that market vis-à-vis the domestic bond market.

Recent developments in the U.K., France and the Benelux countries indicate a growing use of the LBO financing technique. In addition, many observers expect substantial increases in pan-European merger and acquisition activities as EEC integration accelerates, and despite strong distaste in most European countries for hostile takeovers, the presence of well entrenched management in numerous European corporations will in all probability necessitate that form of acquisitive activity.[35]

The implications for the bond markets are two-fold: (1) while LBO debt financing has typically been bank funded in the U.S. and U.K., the lack of sophistication and risk aversion of many continental banks may lead to deal arrangers (as U.S. and U.K. investment/merchant banks) to structure special purpose bond financing and (2) the expected reluctance of most European banks to finance hostile takeovers considering their traditional close "relationship" banking with corporations may lead to investment banks designing and placing "acquisition" paper with sophisticated investors in the form of transferable bonds. It is most probable that the initiators of these potential developments will be U.S., and to a lesser extent, U.K., investment banks who may then become tough competitors to continental banks on their home turf.

Lastly, the growth of European bond markets will heavily follow the growth and mix of institutional portfolio investments. Many factors point to a greater role and importance of institutional funds (to be discussed below). It is expected that the managers of these funds will be increasingly oriented toward improved performance under a more "scaled" level of risks; in other words, instead of placing 50 percent to 70 percent of their portfolio in government bonds, the mix may contain graduations of corporate risks, equities, venture capital and say, LBOs. Additionally, as we discussed above, EEC liberalization will make it harder for governments to force institutions to be "captive" investors of their bond paper.

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[34] See Walter and Smith (1990).

[35] Op. cit.

(b) *Government and Corporate Bond Markets: Operations*

Primary market mechanisms. As noted above, the bulk of the European bond markets is occupied by government paper; this is true in terms of paper outstandings as well as liquidity.[36] As we will see below, most governments have their own established market procedure for issuance and trading of their paper. In addition, a significant portion of all domestic non- government bonds involve the financial institutions sector; as such, many of the banks are able to undertake the issuance of their own paper and ensure active secondary markets. As a result of this heavy concentration of issuer type and the frequent combination of the issuer/underwriter roles, in most European bond markets the number of active participants in the primary markets is limited.

Primary market practices vary from country to country. In Germany, a fixed syndicate of banks led by the Bundesbank underwrites new issues. Currently 93 banks are involved including 20 foreign-owned banks who, as a group, are allocated 20 percent of each issue. In the U.K., France, Italy and Netherlands, a tender bid system (known popularly as the "Dutch Auction") is utilized whereby authorized banks or brokers submit bids for a certain number of bonds at specific prices. The fundamentals vary somewhat: in France the government announces the coupon, redemption features and an approximate amount of all the year's issues at the beginning of the year; in Netherlands the size of the issue is decided at the end of the tender.[37]

Secondary market participants. Secondary market mechanisms vary as well. Bonds in general have to be listed on the various national stock exchanges but, depending on the type of bond, trading is mostly undertaken on an OTC basis (such as Germany's "Geregelter Freiverkehr" or Italy's "parallel market").[38]

In France, bond trading is dominated by the Agents de

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[36] See Salomon Brothers (1988b, 1987a, 1987b) and Banca D'Italia (1988) p. 6.

[37] See Salomon Brothers (1987b and 1988c).

[38] See Salomon Brothers (1987b), p. 10; (1988c), p. 7; (1987a), p. 10; Banca D'Italia (1988), p. 11.

Change who are brokers on the Paris Stock Exchange; they perform a function similar to that of specialists on the NY Stock Exchange and until 1987 they operated a system of bond price fixing at midday. Since 1987, 13 government-appointed dealers make continuous OTC prices for government bonds. Furthermore, after 1992 the legal monopoly of the *Agents de Change* is to be terminated and from 1988 on, French and foreign banks may purchase shareholdings in these brokers.[39]

In Germany and Netherlands, banks act as brokers; all orders reach the stock exchanges via these banks. In the U.K. the 1986 "Big Bang" of deregulation initially boosted the number of gilt market maker from 2 to 29; a shakeout since then has reduced this to 24 and it is expected to further reduce itself to 19.[40]

In Italy, participants in the official secondary market must be licensed stockbrokers who act as brokers and hence cannot trade on the exchanges for their own account. Ninety-five percent of the trading, however, occurs on the parallel market which is totally unregulated and is conducted on an over-the-counter basis and includes major participants as institutional investors, banks, insurance companies and the major industrial companies.[41]

Commission systems, clearing and settlement. Secondary market commission structures across Europe are tending towards the negotiable system evident in U.K. after "Big Bang": in Germany they are already negotiable, in France and Netherlands they vary by deal size and in Italy as most of the trading is done on the OTC, commissions are basically negotiated among players.[42] It is important to point out, however, that in assessing "true" commissions involved (especially for the retail buyers and sellers of bonds) one needs to take into account the current access to immediate comparative price quotation in each country, the lack of which can serve as a means for intermediaries to add hidden commissions in the form of higher prices. European securities settlement systems are discussed of greater length in the European equities section below.

Bond derivative markets. European bond-related derivative markets are concentrated in five financial centers: London Traded Option Market (LTOM), London International Financial Futures Exchange (LIFFE), European Option Exchange (EOE) of Amsterdam, Marché des Options Négociables de Paris (MONEP) and Marché à

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[39] See Op. cit. (1987b), p. 10.

[40] See Walter and Smith (1990).

[41] See Banca D'Italia (1988) p. 11.

[42] See Salomon Brothers (1987b), p. 33; (1988c); (1987a).

Terme International de France (MATIF). Products available range from options, futures, and options on bond futures, all on government securities; trading is most active on long-term government bonds. Germany modified its gambling laws in 1988 in order to establish organized markets for derivative instruments and futures contracts on debt instruments are expected to begin trading in that country in 1990.

(c) *Equity Markets: Basic Profile*

Market sizes and types. European equity markets are characterized by far more diversity, fragmentation and historical idiosyncrasies than their bond markets counterparts. There are two good explanations for this difference: (1) governments, as major participants in bond markets, have borrowed heavily on international capital markets and have consequently tended to adopt international market techniques and (2) the highly integrated Eurobond markets has had a strong spill-over effect onto national bond markets. Yet, as we shall see below, European equity markets are showing signs of integration as well.

As revealed in Table 12, the International Stock Exchange of London (ISE), formerly the London Stock Exchange, is clearly the leading market both in terms of market capitalization and number of domestic and foreign stocks listed. ISE's domestic and total market capitalization of approximately ECU 0.6 and ECU 1.8 trillion, respectively, at year-end 1988 places it third internationally after Tokyo (ECU 3.2 trillion) and New York (ECU 2.1 trillion).[43]

In Europe, ISE holds the leading position as the most "international" of the various equity markets: over 587 foreign stocks listed (it leads the second most international of exchanges, Frankfurt, which has 474 foreign stocks listed). Frankfurt is Europe's second largest in terms of market capitalization (ECU 213 billion) but because of its high turnover ratio vis-à-vis London (1.62 as compared to 0.51), it holds the first position in Europe in terms of sheer annual transaction volume.

There are various reasons for London's supremacy today as Europe's premier equity market: historical head start in terms of capital accumulation and trading of shares stemming from early industrial development; continuous technology interchange with New York and Tokyo in areas of telecommunications, settlement systems and product innovation; beneficial linkages with other areas of capital markets in which London also maintains a key role, notably debt and foreign

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[43] See Fédération Internationale des Bourses de Valeurs (1988, 1987) and Hawawini and Jacquillat (1990).

TABLE 12

European Equity Markets: Size and Activity—December 1988/1987

	Market Cap 12/31/88 local mils.[1]	Market Cap 12/31/88 ECU bils.[2]	Market Cap /GNP 1987[3]	Listed Stocks 12/88[4]	Foreign Stocks 12/88[5]	Transaction Volume 1988 ECU bils.[6]	Turnover Ratio 12/88[7]	Number of Sections 12/87[8]
Belgium	2,195,365	50	30%	337	151	9	0.18	OM, SM, OTC
Denmark	184,761	23	20%	267	7	4	0.17	OM, SM, OTC
France	1,350,506	189	20%	676	217	59	0.31	OM, SM, OTC
Germany	446,619	213	20%	1,083	474	346	1.62	OM,SM, OTC, TM
Italy	176,827,000	115	16%	211	0	26	0.23	OM, SM, TM
Luxembourg	691,174	13	3%	594	172	0.3	0.02	OM, OTC
Netherlands	207,236	88	48%	460	228	26	0.30	OM, SM, TM
U.K.	393,190	602	92%	2,580	587	305	0.51	OM, SM, OTC, TM
Portugal	1,183,000	7	-	143	0	-	NA	OM, OTC
Spain	10,313,057	77	24%	369	0	17	0.22	OM, OTC

[1] Amounts are in billions of local currency, figures are for domestic market capitalization only; Portugal—1987 data only.

[2] Translation in U.S. dollars is based on year-end exchange rate given by The Féderation Internationale des Bourses de Valeurs (FIBV).

[3] 1987 Market capitalization divided by gross national product; source: FIBV, 1988 Report; GNP figures—1987 data.

[4] Total number of listed stocks (domestic and foreign).

[5] Number of foreign listed stocks.

6Annual volume of transaction in billions of ECU.

[7] Annual volume of transaction (6) divided by total market capitalization (2).

[8] OM = official market; SM = Second market; TM = third market; OTC = over the counter, and electronic screen trading.

Source: Féderation Internationale des Bourses de Valeurs; Spicer & Oppenheim, Société des Bourses Française, OECD.

exchange; progressive self-initiated reforms as evidenced recently by "Big Bang" in 1986.[44]

Growth prospects for equity markets. Equity financing in most European markets outside of London has traditionally been weak and has taken a secondary role to debt financing of all forms. Several factors can explain this situation: (1) the heavy government ownership of industry in many states, (2) the holding of shares by banks in the states with universal banking, (3) the lack of liquidity in Continental exchanges, and (4) the general lack of sophistication of most retail investors who concentrated their financial assets in bank products or, at most, bonds.

This situation is changing rapidly. Table 13 reveals the rather dramatic growth in equity financing by all European companies for the three-year period 1985-87. All three categories of equity have risen: domestic equities have more than doubled (from ECU 25 billion to ECU 64 billion) and foreign (non-domestic companies issuing in local markets) and euro-equities (shares issued in the euromarkets) have also shown tremendous growth. This trend is expected to continue for several reasons that concern both primary and secondary markets:

(1) Several governments are undertaking privatization programs in order to liberalize the economy and raise capital. Between 1985 and 1987 approximately ECU 35 billion was raised in Europe from the sale of shares in public-sector corporations.[45] Considering the general success that governments have had in tapping these once dormant capital markets, there is no reason to believe that this trend will not continue.

(2) Universal banks after 1992 may be restricted by EEC legislation, as to the amount of shares of any particular company they can hold. Off-loading of such paper may accelerate in the next few years to comply with the likelihood of the approval of these requirements and hence may promote secondary market liquidity. In fact, in some countries, such as Germany, where banks have held on to major quantities of corporate shares for decades, this off-loading process can in some ways be construed as a form of privatization.

(3) The traditional lack of liquidity in Continental exchanges was mostly due to regulation that prevent intermediaries from trading for their own account and to engage in market making activities as well as from the undercapitalized nature of the intermediaries themselves. Increased competition from London may force Continental exchanges to change their prior stance of investor protection and the entrance of better capitalized

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[44] Op. cit.

[45] See Walter and Smith (1989).

TABLE 13

Equity Market Financing by All European Companies
1985–1987 (in ECU millions*)

	Total Debt Issues			
	Eurobonds Equities	Foreign Equities	Domestic Equities	Total Equities
1985				
Number of issues	45	6		
Volume	2,819	135	25,332	28,286
1986				
Number of issues	107	17		
Volume	12,082	1,990	49,887	63,959
1987				
Number of issues	109	26		
Volume	10,337	2,926	64,389	77,647

*Converted from U.S.$ at year-end 1987 exchange rate.
Source: Securities Data Co. (Euro and foreign data); OECD (domestic data).

universal banks should enable players to capture these new opportunities.

(4) European retail investors are increasingly diversifying their financial portfolios away from bank products. For instance, in all major markets, bond and equity holding mutual funds are showing high growth rates at the expense of traditional deposits and bank certificates of deposits.[46]

(d) *Equity Markets: Operations*

Trading vehicles and price-setting mechanisms. As shown in Table 14, with the exception of London, most Continental equity markets are still of the organized type (similar to New York and Tokyo) whereby official floor trading and hours are maintained and where order are centralized and executed in a single location. Nevertheless, even in Continental markets an interesting development is occurring: off-floor trading for large blocks of shares is tending to drive a significant portion of trades out of the stock exchanges toward broker/dealer offices, or toward London's ISE where liquidity of large blocks of foreign shares is often higher than on the local market of origin.[47]

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[46] While there has been no massive shift from bank deposits into the individual purchase of shares and bonds, there is a definite trend toward the purchase of mutual funds which in turn invest in shares and bonds; see OECD (1988, 1987a).

There are different price-setting mechanisms in the various European equity markets. The dominant batch system is expected to be increasingly replaced by a continuous market system with computer-assisted trading and quotations. Under the former system (used in most Continental exchanges), orders are not transacted immediately but stored and transacted in a "batch"; under the latter system (prevalent in London) transactions occur when two traders' order cross: price setting is automatic and occurs "continuously."

Stock exchange membership. With the exception of Italy, stock exchange membership in Europe does not require the purchase of a "seat" (as in the U.S. or Japan). Table 14 indicates the current number of brokers in the major equity markets. Membership is usually granted by the ruling stock exchanges public or private authority and typically membership comes with a stockbroking monopoly (except in the U.K. where entry is free even for foreign firms). Elsewhere, foreign firms are generally prohibited from national markets, or, if admitted, are submitted to stricter requirements than national brokerage houses.[48] All countries have established minimum capital requirement for firms, a few countries have done the same for individuals with London having detailed requirements according to the nature and scale of business. Likewise, all countries require an annual financial report for listed companies, and a few require more frequent reports (Italy, Netherlands and the U.K.).[49]

Commission systems and taxation. As we saw in the discussion on commissions in European bond markets, the tendency is toward negotiable commissions in European equity transactions. As shown in Table 14, in most of the key European markets, commissions are either totally negotiable (U.K., Germany and Denmark) or partially

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[47] For instance, approximately 25 percent of the capitalization of the most active French shares are traded in London rather than Paris (Hawawini and Jacquillat, 1990). In addition, this development seems to hold true in the case of large block trading of other Continental shares (Hawawini, 1984), p. 155.

[48] As we saw in the discussion of European bond markets, recent reforms in France now permit foreigners to purchase shareholdings in local brokerage houses; similar reforms are in process in Belgium and Spain.

TABLE 14

European Equity Markets: Basic Operation Profile—December 1988

	Number of Exchanges[1] 12/87	Commission Structure	Number of Brokers[2] 12/87	Trading Vehicles[3]	Access to Foreign Firms
Belgian	1	Fixed	314	A,B,C,D,E	No
Denmark	1	Negotiable	46	A,B,C,D,F	No
France	7 (Paris)	Fixed and negotiable	61	A,B,C,D,E,F	Yes
Germany	8 (Frankfurt)	Negotiable	680	A,B,C,D	No
Italy	10 (Milan)	Fixed	230	A,B	No
Luxembourg	1	Fixed and negotiable	74	A,B,C	No
Netherlands	1	Fixed	150	A,B	Yes
Portugal	2 (Lisbon)	Fixed and negotiable	12	A,B	No
Spain	4 (Madrid)	Fixed	87	A	No
U.K.	1	Negotiable	329	A,B,C,D,E	Yes

[1] Location of the principal exchange is given in parentheses.

[2] Three countries have a "numerus clausus" regulation that limits the number of authorized brokers : France, Italy and Spain. This regulation will be removed in July 1989 in Spain and in January 1992 in France.

[3] A=floor trading; B=off-floor trading; C= OTC market; D=continuous market; E=screen trading; F=margin trading.

Source: Fédération Internationale des Bourses de Valeurs; Spicer & Oppenheim; Société des Bourses Françaises, OECD.

negotiable with a ceiling on fixed commissions (France, Luxembourg and Portugal). Others, notably Italy, Netherlands and Spain, continue to have a fixed system with pricing gradations based on transaction size.[50]

Another cost of trading, taxation of capital gains, dividends and the volume of transactions, reflect divergent practices across the markets and result in distortion in the flow and allocation of capital. Capital gains are normally taxed where the investor resides; dividend payments are sometimes subject to withholding; transactions tax is usually proportional to the amount transaction or to the commission charged by brokers. The harmonization of these taxes will remain a difficult issue well beyond January 1993 considering that tax issues are still decided by the unanimity rule among EEC member states.

Clearing and settlement systems. There are numerous clearing and settlement systems in European equity markets; in itself this poses tremendous problems for the integration process. Some countries (Belgium, Denmark, Portugal, and Spain) still practice physical delivery of securities with associated long delays and higher transaction costs. A few countries have a centralized system of clearing and settlement as France's SICOVAM (also Luxembourg and Netherlands); others (Italy and the U.K.) continue to maintain a network of multiple systems.[51] It is hoped that the integration process will assist in the creation of bridges between major Continental stock exchanges and the ISE. Some progress in this direction has already been achieved by France and Germany. In the same vein, we should also mention the Interbourse Data Information System which aims to link all major European exchanges; this effort, however, has met with both technical and administrative obstacles. Without this integrated clearing and settlement system European markets will indeed remain quite fragmented.

Equity derivative markets. There are currently few active equity- related derivative markets in the EEC (see the discussion of derivatives in the bond market for a listing of markets). Equity-related derivative securities can be option contracts on individual common stocks as well as option and future contracts on stock market indices. Option contracts are traded on the LTOM, the EOE, and the MONEP, while futures contracts are traded on the LIFFE and MATIF.[52] There is also an OTC stock option market in Frankfurt which, however, is relatively inactive due partly to the fact that Germany modified its

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[49] See Hawawini and Jacquillat (1990).

[50] Ibid.

[51] Ibid.

[52] Ibid.

"gambling" laws only in 1988 to permit the creation of organized derivative instruments.

Equity markets efficiency. Various studies have been undertaken to assess the informational efficiency of European equity markets; a recent review of the evidence concluded that they could be considered informationally efficient on the three forms of the efficient market hypothesis: weak form, semi-strong form, and strong form.[53] In other words, in European equity markets (1) current prices fully and instantaneously reflect all the information implied by the historical sequence of prices, (2) prices adjust rapidly and fully to publicly available information (limiting the use of such information to earn above normal profits), and (3) potential access to "inside information" does not translate to earning abnormal returns (as indicated by the inability of institutional investors to outperform the market under the assumption that they may have had more favored access to information).

2. Current Trends in European Corporate Finance and Portfolio Investment

European corporate finance. The "splintered" nature of European securities market has had one major effect on corporations taking a pan-European approach to corporate finance: it has effectively managed to contain all but the largest corporations within the confines of national financing sources. As we saw in the introduction, there is a cost to businesses of not having ready access to various types of institutions than those found within the borders of any given European state. How far away are we today from a scenario of pan-European securities market fund raising?

Currently, only large multinational corporations tend to take a pan-European, or indeed global, approach to raising funds via the securities market. For the majority of European middle-market and for some large national companies the main source of funding is their "house" banks.

These limited funding options can be explained by two fundamental reasons. Firstly, unlike in the U.S., there has been no great desire on the part of thinly capitalized investment banks to take the risk of underwriting bonds or equities for these companies, especially in light of the fact the investor demand up to now has at best been lukewarm for anything but well-known bank or government paper. And secondly, until the mid-1980s, exchanges didn't help matters either: cumbersome listing and issuance procedures sent most corporations back into the hands of their reliable (even if more expensive) banks. Hence, for most European companies even accessing their *national* securities market has usually been a daunting challenge, let alone considering a pan-European approach.

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[53] See Hawawini (1984).

This "stagnant" situation is changing across European securities markets, beginning with the major financial centers and progressively spilling over to the smaller markets. As we will see below, EEC legislation in the securities field is as revolutionary as in the banking sector: competition for business from all providers will increase dramatically. And as margins at the large end of the corporate business dwindles, these providers will increasingly look to the middle-market segment, first in their home countries and then on a pan-European basis.

There are signs today that the securities industry is already reacting. Continental exchanges are liberalizing and modernizing their practices to gain a head-start over other exchanges and perhaps to chisel away London's supremacy. Hence, one can almost say with a fair degree of confidence that within the next five to ten years what was once the preserve of major corporations will become within reach for the vast majority of middle-size companies.

European portfolio investments. Evolution in the practices of European portfolio investors go hand-in-hand with the significant changes described above in corporate funding. European investors have long recognized the benefits of portfolio diversification based on the sizable evidence from research done at the international level. Recently, more work has been undertaken on the particular subset of the global stock market that Europe represents.[54] The evidence presented by Hawawini and Jacquillat (1990) indicates that during most of the 1980s, European equity markets have shown correlation coefficients, between their equity return measured both with and without exchange rates, of average magnitude. And the lower the magnitude of the correlation coefficients between the returns of European equity markets, the higher the gains from portfolio diversification. In other words, because European equity markets exhibit cross correlation coefficients of average magnitude, portfolio diversification across European equity market can lower portfolio risk without reducing portfolio returns.

Table 15 presents data evidence in the form of a correlation matrix for all European countries from 1980 to 1988, with returns denominated in the local currencies (the same conclusion holds when returns are measured in a common currency). We see in Table 15, for

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[54] See Hawawini and Jacquillat, op. cit.

TABLE 15

Correlation Matrix of Equity Returns for a Selected Group of Countries Without Exchange Rates, 1980–1988

	Bel.	Den.	Fra.	Ger.	Ita.	Jap.	Neth.	Nor.	Spa.	Swe.	U.K.	U.S.
Belgium	1.000	0.233	0.562	0.500	0.278	0.399	0.486	0.498	0.230	0.281	0.468	0.407
Denmark	0.233	1.000	0.226	0.238	0.291	0.204	0.352	0.301	0.206	0.212	0.234	0.363
France	0.562	0.226	1.000	0.517	0.373	0.311	0.453	0.433	0.271	0.237	0.428	0.481
Germany	0.500	0.238	0.517	1.000	0.259	0.268	0.574	0.417	0.289	0.283	0.405	0.430
Italy	0.278	0.291	0.373	0.259	1.000	0.276	0.384	0.139	0.344	0.270	0.298	0.233
Japan	0.399	0.204	0.311	0.268	0.276	1.000	0.359	0.261	0.315	0.177	0.415	0.317
Netherlands	0.486	0.352	0.453	0.574	0.384	0.359	1.000	0.589	0.316	0.400	0.660	0.630
Norway	0.498	0.301	0.433	0.417	0.139	0.261	0.589	1.000	0.215	0.387	0.487	0.536
Spain	0.230	0.206	0.271	0.289	0.344	0.315	0.316	0.215	1.000	0.271	0.347	0.333
Sweden	0.281	0.212	0.237	0.283	0.270	0.177	0.400	0.387	0.271	1.000	0.397	0.410
U.K.	0.468	0.234	0.428	0.405	0.298	0.415	0.660	0.487	0.347	0.397	1.000	0.637
U.S.	0.407	0.363	0.481	0.430	0.233	0.317	0.630	0.536	0.333	0.410	0.637	1.000

Source: Hawawini and Jacquillat (1990).

example, that the correlation coefficient between the returns of the French and German markets is .517. The square of this correlation coefficient, usually called R^2, indicates the percentage of common variance between the two markets. Here, close to 27 percent of stock price movements are common to the French and German markets.

Few markets exhibit correlation coefficients with other markets that are higher than .500. On Table 15, one can notice the following pairs: France-Belgium (.562), Germany-Belgium (.500), France-Germany (.517), Germany-Netherlands (.574), Netherlands-Norway (.589) and United Kingdom-Netherlands (.660).

The objective of a risk-diversification policy ii to reduce the volatility of a portfolio without lowering significantly its return. Evidence of portfolio volatility and return is found in Table 16 which takes the perspective of German investors. The average annual domestic return for each equity market is given in column 1. Column 2 is the exchange gain component of the return for German investors investing outside of Germany. Column 3 is the total Deutsche Mark (DM) denominated return. The total risk, measured by the standard deviation of DM rates, is presented in column 6. This total risk has two components, the domestic equity risk and the exchange risk, which are given in columns 4 and 5, respectively.

It is clear that, using the German example, the total risk of all other stock markets (with the exception of Denmark and Netherlands) is larger than that of the German market when DM is used as the base currency (even though the domestic risk of some markets might be lower than the risk of the German market due to the exchange rate component). Nevertheless, the evidence indicates that the addition of more risky foreign equities to a purely domestic portfolio still reduces its total risk without lowering significantly its return, as long as the correlation coefficient of the foreign equity market and the domestic market is not too large.

This phenomenon is revealed in Table 16 by comparing columns 3 and 6. Again taking the German example, we see that whereas the *risk* of a European portfolio (16.53 percent annualized standard deviation with the index calculated using the capitalization weights as of end of June 1984) is significantly lower than the risk of any specific market, the *return* of a European portfolio, which is a weighted average of the return for individual countries (19.74 percent), is comparable to the equity return of the various countries that make up our sample. The empirical evidence allows us to draw the same conclusions from the perspective of the French and British investors as shown in Hawawini and Jacquillat (1990).

The general conclusion drawn from the above empirical

TABLE 16
Risk and Return from Perspective of Germany, 1980–1988

Country	Domestic Return (%) (1)	Exchange Gain (%) (2)	Total Return (%) (3)	Domestic Risk (%) (4)	Exchange Risk (%) (5)	Total Risk (%) (6)
Belgium	27.24	–2.49	24.74	21.49	5.89	22.04
Denmark	20.08	–2.34	17.76	19.04	2.42	19.46
France	21.54	–4.27	17.21	23.01	3.84	23.29
Germany	15.16	0.00	15.16	20.30	0.00	20.30
Italy	30.51	–5.27	25.25	28.90	3.66	29.52
Japan	22.37	8.38	31.08	17.51	11.25	21.96
Netherlands	21.38	–0.22	21.16	19.89	1.79	19.97
Norway	15.47	–2.54	13.03	27.92	6.53	29.03
Spain	31.03	–6.12	24.83	22.63	6.48	23.86
Sweden	33.15	–3.75	29.37	23.71	8.02	25.24
U.K.	23.14	–1.58	21.52	19.89	10.87	22.57
U.S.	16.34	1.73	18.10	16.88	12.64	20.93
World[1]	18.32	1.83	20.27	14.33	9.25	17.22
Europe[1]	20.88	–1.65	19.20	15.38	4.88	16.26
World[2]	18.43	2.37	20.93	14.18	9.51	17.24
Europe[2]	21.40	–1.62	19.74	15.42	5.30	16.53
World[3]	20.08	3.65	23.91	13.57	8.66	16.48
Europe[3]	22.06	–1.98	20.04	15.32	5.26	16.46

[1] Index calculated using capitalization weights as of 6/30/80.
[2] Index calculated using capitalization weights as of 6/29/84.
[3] Index calculated using capitalization weights as of 6/30/88.
Source: Hawawini and Jacquillat (1990).

work is that portfolio diversification across European markets would have brought about high risk reduction benefits without a sacrifice in total returns.[55] Similar studies on diversification across European bond markets reveal similar opportunities although somewhat less pronounced[56] because correlation coefficients between bond market returns are significantly higher than those between equity market returns.

Two key questions arise: one, what are the obstacles to building a pan-European portfolio of investments; and two, will integration reduce these diversification opportunities by increasing correlation coefficients significantly (integration should increase market interdependence and hence raise cross correlation coefficients)? Our discussion above on the highly diverse set of rules and practices in the operations of both bond and equity markets answers the first question: except for the bonds and stocks of the largest corporations, much of which is issued and traded in London (eurobonds or euroequities) pan-European portfolio investing remains quite a challenging task today.

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[55] Ibid.

[56] See Jorion (1987).

Regarding the second question, it has been argued that European integration may result in statistically significant increases, over the next five to ten years, in correlation coefficients between major European equity market returns.[57] Nevertheless there are several factors that more than offset the reduction in diversification opportunity: increased operational and informational efficiencies as well as the possibility of future European investors taking a "focused diversification" approach. Said otherwise, as markets integrate many of the obstacles mentioned in the above paragraph will diminish; furthermore, portfolio diversification in an integrated Europe could take an "industry-sector," "company-size," or "economic/geographic pockets" approach.[58]

3. Summary

Despite its current fragmented character, the European securities industry is showing distinct signs of structural and operational integration. Competitive forces are at work across the various national markets and among all categories of participants.

Retail and institutional investors are growing in number, becoming more sophisticated and are willing to cross borders to deal with intermediaries that offer the optimal price-value service.

Traditionally undynamic and protected national exchanges are being jolted by the realization that preparations for 1993 by other exchanges may leave them as stagnant backwaters of finance; they are self-liberalizing and modernizing as never before in their history.

And intermediaries, long used to a cosy existence of monopolistic service provision, are finally realizing that their home governments are opening their markets to foreign participants and that each basis point of even domestic commission income will have to be competed for on the basis of efficient service.

Considering these factors, it is likely that European securities industry will have already achieved some form of integration by 1993.

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[57] See Hawawini and Jacquillat, op. cit.

[58] Ibid.

V. Current Regulatory Barriers and EEC Legislative Efforts

The obstacles to taking truly pan-European banking or securities strategies as we discussed it above, lie in a differing mix of direct and indirect barriers that exist in each EEC countries for each of these financial sectors.

In the banking industry for example, most EEC countries do not have visible barriers designed to favor domestic versus foreign participants. Instead, one has to look to the diverse practices that each country applies equitably to all participants within its borders: capital controls, limits on equity participations in corporations, solvency and capital requirements, limits on paying market interest rates on certain types of deposits, restriction on securities transactions, differences in tax treatment of interest and dividend income and varying bank secrecy laws.

On the other hand, in the securities industry, participants are burdened not only with indirect barriers (in the form of different practices and standards in each country) but also with certain important direct barriers : regulations in certain national exchanges which prevent foreigners from being licensed as brokers and limitations in some countries on the holding of foreign securities by national pension funds and insurance companies. In addition, of course, participants in some countries have had to contend with still lingering exchange controls which made multi-country portfolio investing extremely difficult. Or, in the case of Germany and Belgium, where participants wishing to provide securities trading had to first obtain a full banking license and offer a full range of services.

The EEC is attempting to harmonize away these numerous regulatory barriers and local practices using the philosophy of "dynamic disequilibria" we discussed above. In practice, this has spawned several key directives in both the banking and securities sectors. Exhibits 1 and 2 summarizes the key directives which concern the European banking and securities sectors.

The Capital Movements Directive of 1988 (an extension of a 1986 directive) is common to both sectors and indeed can be viewed as a "foundation" directive.[59] It enables free capital flows of all types and lays the groundwork for two other key directives, the Second Banking Directive and the Investment Services Directive (see Exhibit 2) which, if achieved in entirety, will result in an integrated European financial market.[60]

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[59] Before the 1988 amendment, the Commission had identified four different categories of capital movements with greater discretion for national authorities in deciding the type of restrictions to place on two of these categories which were not directly

These latter two directives are supplemented by approximately 20 directives all of which, as a whole, attempt to harmonize the most glaring differences among the EEC countries, push through the rather revolutionary notion that each country should recognize the other countries' supervisory criteria, and that financial intermediaries properly registered in one country should be able to offer their services across the EEC and be supervised by their "designated" home country.

Assessing the likelihood of success of these directives is at best a difficult task: numerous country-specific factors mix, both for and against financial integration, and making confident statements one way or another lie in the realm of sooth-saying. Nevertheless, certain "guarded" comments may be made and some outcomes can be anticipated:

(1) Despite historical national dislikes to releasing full control of national money supplies, strong pressure from investors (private, corporate, and institutional), and financial intermediaries, will probably result in the realization of the directive on capital movements. In fact, as integration progresses, countries that resist full liberalization of capital movements may, in reality, find themselves faced with hidden outflows.

(2) Most of the directives on harmonizing various banking and securities markets rules, definitions, and standards will most probably be realized and enforced within the next three to ten (for some of the

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Note 59, *continued*

related to trade flows, listed securities flows or direct investment flows (e.g., money market transactions). In addition, countries were free to use a "safeguard clause" (under Articles 73, 108 and 109 of the Treaty of Rome) of placing certain capital flows restrictions to protect one country's external position.

[60] In this respect, the successful enforcement of the capital movements directive should be greatly aided by some agreement of the directive for a Europe-wide withholding tax on interest income. At that point, investment funds will flow not where there are tax advantages, but where the investing infrastructures are optimal (e.g., efficient intermediaries, sophisticated settlement systems, and better overall risk-adjusted returns, etc.). Nevertheless, unless there is an EEC-wide harmonization of taxation schedules for personal income, or unless all EEC banks agree to report interest income to the respective home country tax authorities (which is not the option favored by the EEC), it is likely that income tax-distorted capital flows among the 12 states will continue to exist even if the withholding taxes are harmonized.

EXHIBIT 1

European Banking Industry—Key Directives

Name/Subject	Aim	Status/Comments
Directive on capital movements (1988; an extension of a related 1986 directive; this directive repeals an earlier series of directives that started in 1960 and culminated in 1986).	Removes exchange controls and allows the free movement of capital throughout the EEC, with safeguards to prevent short-term instability.	Adopted by Council in June 1988; Spain, Ireland, Greece and Portugal have until 1992 to comply; at the time U.K., Germany, the Benelux countries, and Denmark had abolished all exchange controls.
First Banking Directive (1977).	First attempt to achieve minimum standards for regulating banks and other "credit" institutions that take deposits and lend money.	Adopted by Council in December 1977; was the foundation for the Second Banking Directive.
Directive on consolidated supervision of banks (1983).	Assures that Credit institutions are supervised on a consolidated basis.	Adopted by Council in June 1983.
Directive on bank accounts (1986).	Attempt to harmonize accounting rules (annual and consolidated) for credit institutions.	Adopted by Council in December 1986; this directive sets new standards, including reporting banks' securities portfolios at current value and historic cost.
Directive on bank branch accounts (1986).	Lays down reporting standards for branches whose head offices are located outside the EEC.	Proposed; to be enforced on Dec. 31, 1990; reduces public scrutiny of branch operations; foreign banks likely to convert more subsidiaries to branches.

Name/Subject	Aim	Status/Comments
Second Banking Directive (1987).	Brings further harmonization of laws so that credit institutions can offer services freely across the EEC (see text for further discussion of this directive).	Proposed; still under debate on contentious issues as bank's equity participation in nonfinancial institutions and reciprocity vis-à-vis non-EEC countries; most likely to be adopted in some form and enforced by December 31, 1992.
Directive on bank's own equity capital (originally proposed in 1986, amended in 1988).	Harmonizes definition of bank capital (compatible with Basel Committee and and Group of Ten capital adequacy standards).	Proposed; enforcement date undecided; this directive goes in tandem with the Second Banking Directive.
Directive on bank solvency ratios (1988).	Harmonizes solvency ratios for credit institutions; sets the risk asset weightings for on/off balance sheet items.	Proposed; enforcement date undecided; this directive goes in tandem with the Second Banking Directive.
Directive on bank bankruptcy (1985).	Harmonizes laws for winding up or restructuring insolvent credit institutions; home country rules will apply for branches in other EEC countries whose home bank is insolvent.	Proposed; unlikely to go through quickly as some countries feel the directive is unwarranted.
Directive on mortgage credit (1984; amended 1987).	Allows mortgage lenders to lend and raise funds in other countries without having to be authorized locally.	Proposed; could disappear completely into the Second Banking Directive as in some ways this was the "dry run" for that directive.

EXHIBIT 2

European Securities Industry—Key Directives

Name/Subject	Aim	Status/Comments
Directive on admissions to EE stock exchanges (1979, amended 1982)	Set a policy of mutual recognition and minimum standards for company on stock exchanges with the goal of making it easier for companies to raise capital on a pan-European basis.	In-force except in Belgium & Spain. Countries cannot refuse a listing on the grounds that the company has not been listed or another exchange first but they can turn it down for investor "protection" reasons.
Directive on listing particulars for equity issuance on exchanges (1980, amended 1982, 1987)	Sets basic standards for information that companies are required to furnish the exchanges for obtaining a listing.	In-force in nine countries.
Directive on interim reports (1982)	Sets minimum standards for interim reports of listed companies; establishes that interim reports must be published within four months of end of six-month period.	In-force except in Belgium. Reports must be comparable to same period in the previous year. Excludes UCITS.
Directive on UCITS (1985, amended 1988)	Coordinates laws & rules for UCITS (collective investments in transferable securities); principle is that a unit trust, approved in one state and meeting basic standards set by directive, can be sold anywhere in the EEC without further approval.	In-force since 01/10/89, except for Greece and Portugal which have until 01/04/92.

Exhibit 2, continued on next page

Name/Subject	Aim	Status/Comments
Directive on securities transaction tax (1987)	Aims to abolish indirect taxes (stamp duties) on securities transactions; does not apply to VAT on commissions.	Proposal stage; anticipated enforcement in 1990. This directive is part of the overall tax program of the EEC.
Diretive on prospectus scrutiny, and distribution of prospectuses	Aims to harmonize rules for public offer prospectuses; this also applies to unlisted securities where a simpler format is required.	Enacted; no enforcement date established. Various exemptions included in the proposal.
Directive on large shareholdings disclosure (1979 amended 1988)	Ensures that investors/regulators are aware of major changes in ownership; shareholder must inform company and/or regulator within seven days when holding goes above or below 10%, 20%, 33.3%, 50%, or 66.6%.	Enacted; enforcement date is 01/01/91. Main problem should prove to be implementation; for example, the U.K. has a system where shares are registered by a company, while France & Germany have bearer securities cleared electronically through SICOVAM and Kassenverein.
Directive on insider trading (1987)	Aims to harmonize diverse rules on insider trading; defines "insider" broadly to include "tippee," i.e., people that information is passed to and without any connection to the company; defines "information" as that which is unpublished, specific, related to one or more issuers of securities, and be likely to have a material effect on the price of the security.	Proposal stage; anticipated enforcement by 31/12/90. Distinguishes between "primary" and "secondary" insiders.

EXHIBIT 2—continued

Name/Subject	Aim	Status/Comments
Directive on investment services (in draft form)	Similar to the Second Banking Directive, it allows firms to carry out specified investment services (including selling securities) throughout the EEC if they are authorized by the home country; expected to be a simpler model than the U.K. self-regulating system.	"Embryo" stage; anticipated enforcement by 31/12/92.

Source: Compiled from various sources, including *The Banker*, 1988 and the European Commission Directorate-General 15.

newer member countries) years. In the case of the banking industry these efforts are often part of a larger framework of international harmonization of standards (such as the Bank for International Settlement, the bilateral central bank agreements and the OECD). In the case of the securities industry, the growing use of standard technology applications frequently serves as "harmonizer" of disparate standards.

In both industries, there is no intrinsic country resistance to oppose the creation, in theory, of a level European playing ground via these harmonizations. Yet some "harmonization" directives could prove to be a problem in enforcement.

In the securities field, for instance, in order to realize the Directive stipulating disclosure of large shareholdings, a certain level of honesty on the part of the shareholder will need to be relied upon especially in those countries where bearer securities are cleared electronically. And the Directive controlling insider trading, despite efforts to define "insider" will, in all probability, result in monitoring nightmares unless the EEC creates a strong-arm agency (like the Securities and Exchange Commission in the U.S.) with a mandate to monitor compliance across European equity markets.

And in the banking arena, the Second Banking Directive may prove to be quite controversial in negotiation and in enforcement. There are numerous conflict-raising issues such as, for example, limits on bank equity participation in nonfinancial businesses, the practical split of supervision by home and host authorities and the level of freedom to be given to non-EEC institutions.

In a nutshell, we can be fairly confident in saying that while the major directives under proposal in the financial sector will be approved in some form or another, the true test of their success, that is, their enforcement in each EEC country, will take place in a checkered fashion for at least five to ten years after 1992.

VI. Strategic Implications of an Integrated European Financial Market for Major Participants

Prophesying, even in the form of hypotheses, is a dangerous game especially in the context of European financial integration. As we have seen above, numerous economic, technological, political, and even global factors converge at different speeds and importances in making or braking the integration of European financial markets. In this section, we attempt to lay out, in a rather broad fashion, some of what we consider to be the key strategic implications for various participants in an increasingly integrated European financial services industry.

1. European Financial Services

a. The current process whereby functionally specialized banking institutions are encroaching on each other's traditional market segments cannot result in a sustainable market structure.

b. The shakeout of this process, coupled with the effects of EC integration, will lead to market consolidation which will first occur at the national level and later followed at the European level.

c. The strategic roles chosen by the remaining participants will require the acquisition of different managerial skills than those that served them during the pre-1992 period.

As we discussed in the banking section above, European financial intermediaries, to the period up to roughly 1975, played rather specialized "roles." Since then, the impact in each country, at different speeds, of national and international financial deregulation and market competition has resulted in a situation whereby the "deepening" the scale of operations became difficult (due to market saturation in core banking businesses), prompting banks to increasingly turn to diversification of products and services.

That 10,000 formerly specialized European banks are all moving toward some form of universal banking is not negative *per se*.

especially if all of them can provide cost-effective products at competitive prices. But, in practice, this is highly unlikely due, in part, to the fact that, at a certain point, the managerial difficulty of managing an ever-growing product range more than negates the potential tapping of product operational synergies.

The initial effect of this "herd strategy" of diversification will be a downward pressure on product margins as competition intensifies. As margins in these "new" areas are squeezed and continued subsidizing of losses from the slim-margin traditional business becomes impossible, only the most innovative or highly efficient small banks will survive. And unless even such banks focus their managerial effort in certain market niches (as a strategy of "offer all things to some people" or *vice versa*), they will find that the demands of multi-business management in banking too complex and costly in terms of attracting the necessary trained management.

This excessive competitive environment is being exacerbated not only by the appearance of new non-financial entrants (as retailers and industrial company "financial" subsidiaries) but also by the EEC legislation in the financial area. The shakeout of this process is already leading to national consolidation of participants (either through mergers and acquisitions of entire banks, or through the sale of individual non-strategic business units).

On the European level, balance-sheet type consolidation will probably not take place until a period nearer to 1992 and even well beyond that. In the meantime, the larger European banks may opt for strategic alliances (ranging from the vaguely defined versions to the very specific joint business development in a particular product or client segment), while the smaller banks may seek to be acquired by larger foreign "white knight" banks. Interestingly, to date, very few banks (regardless of size) have deliberately taken a truly pan-European approach: most have contented themselves with a wait-and-see strategy to deal with the "1992 question" while pursuing an active defense strategy for their home market positions.

What type of banking intermediaries will successfully emerge out of this consolidation process and what skills will they need to build to survive and prosper in the post-integration environment? We argue that three generic types may be discernable in the future of European banking, with differing levels of success: (1) pan-European universal banks, (2) pan-European specialized banks, and (3) large national universal banks. For competitive reasons discussed above, it is unlikely that many banks in the one category that is excluded, namely, the smaller national specialized banks, will survive.

There is room for only a handful of pan-European universal banks offering all services to most client segments in nearly all EEC-12 countries. Successful players in this group will need to develop numerous skills that center around the management of complex banking institutions. In part, success will be determined by those institutions that innovate and perfect a product or client business system within *any* given national market (and not just from the home market) and quickly *tailor* and transfer the approach to each of the other national markets. In other words, innovation should be encouraged from any given market and in turn this entails a "de-layering" of managerial control downwards from the head office. Naturally, also needed are other key skills as multi-country strategic cost accounting (for product/client profitability analyses), multi-currency funding and asset-and-liability management, and human resource management across many cultures with increased cross-country mobility of professional staffing, among others.

The pan-European specialized banks could be those that take either a product-group focus or a client-segment focus. While their managerial task is made somewhat easier by the fact that they are not burdened with a complex matrix of products, clients, and countries, they also have less ability to rely on profits of one business area to support another during any lean years. Nevertheless, their very focus is also their competitive advantage giving them flexibility in reacting to changes in demands of their end clients. Additionally, a European field of operations will enable them to build scale and diversify their business risk. The skills necessary for this segment will include all of the above cited for the first group, but in addition, they will need the strategic skill of choosing the *right* segment and defining its characteristics and parameters. Moreover, they will need to fight the natural tendency of most specialized institutions to start diversification in response to competition instead of further improving operational efficiencies.

Large national universal banks will find life in the 1990s extremely uncomfortable: pan-European universal and specialized banks will be utilizing their respective competitive advantages to capture local market shares. And for many large national banks, their size is due to traditional monopolies of client or product segments that are already falling with national deregulation (even before EEC reforms are considered). Their potential strength, in any case, is their typical vast branch networks and a somewhat traditionally "loyal" clientele. Capitalizing on these advantages will require a separation of the strategies that need to be developed for the retail and wholesale client sectors. On the retail side, new essential skills will include managing individual branch profitability through micro-marketing techniques (which the other two groups may not afford to undertake) and managing product offering that captures cross-selling opportunities without excessively increasing fixed costs. On the wholesale side (corporate and institutional clients), large national banks may find it advantageous to collaborate with players from the first two groups by focusing on certain parts of the business system (such as funding and marketing instead of new product development or off-loading of paper in the secondary markets).

2. The European Retail Consumer

a. Retail consumers will be faced with a panoply of products/services provided by local and European intermediaries through numerous market channels, many of which will be non-traditional.

b. Although retail consumers as a group should benefit greatly from the formation of a single financial market, the financially sophisticated sub-group of retail consumers among them should benefit proportionately more.

c. However, capitalizing on these opportunities even for the sophisticated sub-group will necessitate the development of new borrower and investor skills which were unimportant in the past.

One of the major outcomes of EEC legislative reforms should be the proliferation of new products and services across Europe offered not just by local banks and securities brokers but by other European institutions. The ability to offer services throughout the EEC with only one license will increasingly result in European financial institutions trying non-traditional marketing channels, often based in their home country. Coupled with this, the freedom of capital movements will permit retail consumers to have mobility in their borrowing and investing practices.

If European financial integration is achieved on schedule, the following should be an altogether realistic scenario in the retail banking in the 1990s: an Italian office worker in Milan uses a local national bank for his current account needs, takes a low interest-rate Deutsche Mark mortgage loan from a U.K. building society marketing out of Madrid which also sells him an exchange-rate coverage, places his savings in ECUs with a German universal bank based in Luxembourg, and purchases Lira-denominated variable life insurance from a Dutch company, by mail, from its Rome office.

It may be highly improbable that this will be the scenario for the average individual. Therefore, although we observed in our discussion on potential price reductions in financial services that consumers stand to gain *on average* in terms of lower borrowing costs and higher investment returns, this remark needs to be qualified. Hence our hypothesis that European financial integration should disproportionately benefit the financially sophisticated individual who can see the checker-board pattern of individual product cost-differentials across Europe and selectively "shop around" for the best price-value mix.

There are many pitfalls involved in pan-European shopping, requiring the development of new skills. National consumer protection legislation may diminish as home country supervision becomes the guiding rule. While accounting standards may become more standardized, foreign intermediaries may publish financial statements in limited number of languages hence making risk assessment more difficult for some. The first five years of post integration may turn into a somewhat volatile period as financial intermediaries go in (and out) of new businesses and markets. This will make client commitment to, and reliance on, any one institution difficult to sustain.

And considering that progress toward unified monetary and fiscal policies may take us well into the next century, European retail equity and bond investors will have to contend with evaluating various currency risks, general economic risks and industry-specific market risks before embarking on a pan-European investment strategy, which for other reasons (as we will discuss below) should become easier.

3. The European Corporate Client

a. Corporate financing should increasingly take on a European perspective as the range of financing options expands from traditional bank borrowing to include more active tapping of national and European securities markets.

b. Within corporations as a group, the "new" beneficiaries should be small and middle market companies rather than large multinationals who in many aspects are already operating on a pan-European basis.

c. Serving these corporate finance needs requires the acquisition of new skills and systems on the part of financial intermediaries as well as different organizational structures that correspond to the needs of the client segments they plan to serve.

We discussed in our section on European securities markets that European companies are beginning to explore non-bank sources of funding. We observed that this was due to numerous inter-linked factors. Domestic bond and equity markets are becoming vibrant and national and international deregulatory tendencies are jolting both national exchanges (who fear foreign and OTC market competition) and domestic brokers into modernizing their infrastructures and operating practices in order to build more efficient markets. Encouraging this process are the various EEC legislative reforms which will allow intermediaries to operate freely across all EEC markets. These developments have opened to corporate managers a rich gamut of financing options which was unavailable in the past for all but a few large corporations.

While currently the government sector dominates most national bond markets, and tapping the Eurobond markets is still the prerogative of large and well-known companies, we cited various reasons that point to more lively domestic corporate bond markets, including, the future ability of banks to underwrite and trade corporate bonds (as universal banks), the trend towards increased merger and acquisition activities in general, and LBO activities more specifically, (partially from anticipated increased corporate restructuring activity) and a potential greater demand from Europe's growing institutional funds for higher return corporate bond paper over domestic government paper.

Likewise, various factors are expected to push the use of European equity financing, including privatization programs, off-loading of universal banks' equity holdings in light of possible EEC requirements, the future ability of brokers to trade for their own account, and the growing awareness of equity risk and consequent demand for equity paper among retail and institutional investors.

European equity exchanges, especially in the major financial centers, are rapidly modernizing their infrastructure and self-liberalizing in order to be viewed as being operationally efficient by corporations and investors alike. We observed how rules/practices on exchange membership, transaction commissions, and clearing and settlement systems are being streamlined and slowly standardized at a Europe-wide level.

While even the large European companies will gain from these improvements in the functioning of securities markets, it is especially the small and middle-market companies who will reap the most benefits. We saw earlier how this sector was traditionally neglected by the banks. In addition, they had little hope of being nurtured by the securities houses who, in most European countries are (until 1992) prohibited from holding and trading securities for their own account. Faced with reluctance of investors to hold small corporate paper, these securities houses felt no reason to place much effort on this sector.

This situation should change for several reasons. In addition to those improvements in securities market conditions that we discussed above, one has to include the changing nature of competition for corporate business. With universal banking after 1992, well-capitalized commercial banks will start competing with brokers on the upper-end of corporate market, to underwrite and make secondary markets in their shares either on or off the exchanges. Most of this action will be among a handful of players and is expected to gravitate toward the key financial centers of Europe, with London predominating. The vast majority of European banks and brokers should then begin to focus their attention on understanding the credit and equity risk of middle-size companies, propose tailored financing packages that should include a open market securities portion, and literally "grow" the relationship.

Success in serving these non-traditional corporate finance needs will not be easy for most banks or brokers. Needed are new skills, sophisticated integrated systems, and a highly flexible yet linked organizational framework. For instance, pan-European intermediaries wishing to tap small and middle-size companies need to build credible research capabilities either through acquisition, internal development or through strategic alliances with research houses in multiple European countries. In addition, intermediaries have to integrate their operating system and tailor their organizational and business system approach in accordance with the client segments they are targeting. For a universal financial intermediary, an integrated one (from origination to distribution) may be advantageous for the middle market but will be extremely costly for the upper-end of companies. On the other hand, focused intermediaries (as brokers) specializing across Europe in certain industry categories may find it cost-effective to serve across the business system, across the size spectrum, and across countries, provided that operating scale and synergies are achieved.

4. European Institutional Investors

a. European institutional investors should play an increasingly important role in national and European securities markets.

b. This enhanced role will be aided by national and EEC reforms which should encourage the diversification of institutional portfolios away from a heavy reliance on local investment vehicles toward a more pan-European investment approach.

c. Financial intermediaries that wish to serve the growing investment needs of these institutional investors will need to develop specific skills on a pan-European basis and decide what aspects (if not all) of the business system they intend to focus on.

The primary impetus to the growing importance of European institutional investors is derived from the continued development of mutual and pension funds. The European mutual funds market today is estimated at over 420 billion ECUs and further growth can be expected from both the retail and institutional side seeking higher returns without foregoing too much liquidity.[61] European pension funds are rapidly shifting from a redistribution system to a capitalization system. In the former, contributions made by individuals currently working are immediately redistributed to current pensioners, whereas in the latter, funds collected from individuals are invested for future distribution according to certain investment criteria. The effect of this trend will be to increase the current size of funded pensions.[62]

As these funds grow in size, the institutions that manage them will increasingly play a greater role in the actual dynamics of securities markets. Typically, institutional market participants transact in vast quantities of securities. Hence, they will have larger effects on price movements in any individual securities market especially those with limited "depth" (i.e., liquidity). In turn, this implies that these institutional investors will tend to gravitate their transactions toward those financial centers where they can take "active" approach to managing their large portfolios than in those where they are forced to take a "buy-and-hold" attitude. In addition to the importance of liquidity, these institutional investors will naturally favor those financial centers where trading information is readily accessible, where intermediaries are cost effective and where settlement and clearing processes are efficient.

While these funds grow in size, their composition can also be expected to be enriched by national and EEC reforms. For example, EEC directives enabling free movement of capital and European-wide offering of financial services will make it extremely difficult, and in some ways practically impossible, for governments to dictate the composition of pension funds (as insisting that certain percentages be kept in government paper). In addition, the managers of these funds should be increasingly pressured to produce superior results by their end-investors. This may force many institutional fund managers to enhance the risk-return profile by taking more sophisticated and research-intensive portfolio management strategies and increasingly these may be viewed on a European basis.

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[61] Spicer & Oppenheimer (1989), p. 1.

[62] See Hawawini and Jacquillat (1990).

Several factors will aid this "pan-Europeanization" tendency. We saw in our discussion on diversification potential across European equity and bond markets that these opportunities exist and that, while European integration may reduce these diversification benefits, they should be offset by improvements in informational and operation efficiencies. Moreover, the sheer sizes of these institutional funds will lead them to quickly outgrow their traditional home markets which no longer can provide the rich portfolio mixes that would be possible on a pan-European basis (see earlier discussion).

As European institutional investors grow and become more sophisticated in their investment strategies, it goes without saying that financial intermediaries will need to rapidly develop strategies that meet the needs of these investors. As institutional investors trade in enormous blocks they will favor intermediaries who can serve as "dealers" (those with an ability to position securities for their own book) over simple "brokers" (those that trade only on behalf of customer orders). This in turn has significant implications for capitalization of European brokers. While EEC reforms will enable them to position for their own account, they also set guidelines for capital requirements for various types of instruments. Currently, in many countries, brokers are thinly capitalized. We hence may witness increased levels of acquisitions of such brokers by major well-capitalized banks wanting to develop their capital markets business.

We stressed the importance that institutional investors will place on excellent research and market information and increasingly so on a European-wide basis. In other words, successful intermediaries will be extensively called upon for their "informational" capability (i.e., their knowledge of who the buyers and sellers are) in addition to their execution capability. This implies that purely "national" brokers/dealers may either need to develop or acquire these capabilities in other EEC countries or that they develop strategic alliances with other players in the form of a clearly defined consortium. Pan-European universal banks may opt to offer services across the institutional investment business system (from in-house research in each country to active secondary market-making in all major EEC markets). Others may choose to specialize in one aspect of the business system but on a European basis (as, say, research capabilities in each of the 12 countries tightly integrated by sophisticated telecommunications networks).

5. The Role of National Governments in Influencing Financial Markets

a. National and EEC deregulation trends, as well as mounting pressure for the establishment of a European central bank, should diminish the role and relative power of European governments in the financial markets.

b. As governments begin to lose direct and indirect control over their respective financial markets and compete more or less on equal grounds with other participants, the need for better understanding the parameters of other borrowers and ultimate investors should become critical.

We observed in our various discussions above of the past importance of the government sector in European financial markets. Government ownership of banks is still high in many European countries. Primary domestic bond markets are primarily dominated by the state and quasi-state sectors. Many governments still impose investment criteria on insurance or pension funds that emphasize the holdings of government securities. Governments, in most European states, used to control the criteria by which intermediaries (especially foreign) could enter and participate in domestic capital markets. And last but not least, many governments tightly imposed controls on private capital movements.

In both the banking and securities market sections we reviewed numerous reasons why the past situation summarized above is rapidly changing. Privatization programs are increasing in popularity as deficit-ridden governments successfully tap the relatively buoyant equity markets. Although the government role in domestic bond markets will continue to be paramount, we discussed the potential increased share of the corporate sector in the primary market, especially arising from an increase in bond issuance from corporate restructuring. In addition, we observed that EEC reforms concerning freedom of capital movements and the freedom of establishment and offering of products/services should greatly diminish the last three examples of government importance in financial markets mentioned in the above paragraph.

In conjunction with all these factors of change, the latter part of 1989 has witnessed the increasingly vocal calls for a single European central bank by the proponents of a completely integrated financial *and* monetary market in the twelve EEC countries. The practical implication for each country of such a supranational organization would be to further reduce the role of European governments in monetary policy-making.

At a minimum, these supporters insist on greater harmonization of monetary policies across the Community with the EMS playing the guiding monetary mechanism and the European Currency Unit (ECU) assuming a quasi single-currency role. However, recognizing that this consensus approach in the European context may limit optimal policy making by subjecting it to political considerations of each individual government, as a final goal, they argue for a truly independent central bank, with professional central bankers owing allegiance not to their home state, but to a "European state." This new institution would hold full authority to create and distribute money via the old national central banks which would then be stripped of their current independent monetary policy-making role and be responsible for effecting payments and executing regional open-market operations.

The opponents of the notion of a European central bank publicly argue that full economic integration should precede any calls for monetary integration with a single currency. However, their private fears stem from the fact that the effective establishment of a European central bank would require the full participation of the German Bundesbank not only because it represents the largest economy but also because it controls the creation of the current linchpin currency of the EMS, the Deutsche Mark.

And while the Bundesbank has traditionally been reticent about calling for a European central bank, it has more recently had to react to such calls from several other European countries (notably France and Italy). In early 1990, the German Bundesbank governor outlined a bold program for the creation of a totally independent institution with the unwritten implication that German participation would be forthcoming only on the high monetary policy standards that Germany considers it places upon itself (with its tight approach to inflation control).[61] Quickly dubbed the "Euro-Bundesbank" plan by its opponents, who feared that all of Europe would be then playing to a German tune (despite the fact that it could prove beneficial for a financially integrated Europe), it is clear that the path to full monetary integration will still be on the negotiating table for some time to come. Nevertheless, the fact remains that even this once sacrosanct preserve of governments, the control of local monetary policy, is under attack in a financially integrating Europe.

As the relative role of European governments in national financial markets continues to wane over the next decade, governments may have to increasingly view themselves as competitors for capital with other borrowers. In addition, European financial integration implies a more "holistic" view of national monetary management, one that is indeed more "European" in perspective.

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[61] See Norman (1990).

Without the "captive" investors discussed above, and without the ability to impose capital controls, the credit worthiness of governments will increasingly be judged by national investors similar to the way local corporations are evaluated. Governments are used to this level of scrutiny and investment evaluation at the international level of fund raising (e.g., in the London syndicated loan market). But most are barely prepared for local investors to start to regard them as "one of many investment options." In turn, governments will need to understand the "buying criteria" of retail and institutional investors and begin to tailor their instruments to these preferences. For many governments this may mean a radical change of mentality from the days when whatever they chose to issue in whatever period of the year was simply absorbed by investors who had limited alternative investment opportunities.

In a financially integrated Europe, monetary management becomes increasingly exposed to external factors frequently beyond the control of the national government. For certain countries with excessive deficit financing, interest rates may have to rise as the capital markets "equilibrate" themselves in terms of capital allocation with a European perspective. And in the post-1992 era the significant players in national markets may often be non-local with no particular vested interest in buying specific amounts of government paper in order to be on "good terms" with the respective authorities.

Relatedly, as European financial markets integrate, national governments will systematically need to consider "Europe" as the national market in terms of evaluating the impacts of other regions' macro-economic policies on *their* region's financial system. In other words, national debt financing can no longer be viewed from a local perspective. Movements in, say, Italian money supply should trickle through the various European capital markets more rapidly than in the past and have repercussions in, say, Danish and Belgian government financing patterns. National governments, then, will find that what was once a locally manageable concern becomes far more intertwined with the actions and reactions of other EEC states. In turn, this implies the need for greater skills at European level negotiation and coordination of monetary and fiscal policies.

6. The Two-Tiered Structure in Financial Services

a. As European markets in financial services integrate, we may witness the development of a two-tiered market structure: one, more centralized market, revolving around the largest corporate and institutional clients and the other, more decentralized market, focusing on smaller national corporations and retail clients.

b. This double-tiered structure, however, will differ in its characteristics when comparing the banking sector with the securities sector. Moreover, these two "levels" should be increasingly efficiently linked, both in terms of telecommunications and in terms of market dynamics.

c. The strategies that financial intermediaries choose and nurture for the next decade should take these future market structure characteristics into account in order to build realistic and viable positions in an integrated European financial market.

In many of our discussions above, we have implied that the structure of European financial markets is evolving into what can be characterized as a two-tiered market. Under this structure, few key financial cities, will serve as "hub" centers attracting major corporate and institutional clients from across Europe, while other major cities will serve as "satellite" centers of differing importance that focus on serving smaller national companies and retail clients. Nevertheless, an interesting and important distinction needs to be made when speaking about the implications of this market tiering for the banking sector or the securities sector.

We observed in our analysis of the securities market that London, for numerous reasons, was consolidating its position as "the" key center for the Eurobond and Euroequities markets, with cities such as Frankfurt, Paris, and Amsterdam all vying to build strong positions in the home market (to keep the upper-end of the market from drifting to London) and to increasingly attract some of London's business through the promotion of their nascent bond and equity-related derivative markets.

London's developing role as the European "link" in the global equity market stems from (1) its vast market size and concentration of activity, (2) the existence of cross-links to other major capital markets such as bank debt syndication and foreign exchange, (3) the enormous investments the "City" has made in data processing and telecommunications equipment that enhance its operational efficiency, (4) the combination of these other factors which enables London to provide liquidity for block-trading and derivative markets.

In banking, however, a different from of two-tiering should occur. London may still be predominant, but only for certain banking products/services (such as activities related to key capital markets products as Eurobonds, major private placements, more sophisticated and esoteric parts of the swaps market, and foreign exchange). Indeed London- based banks (especially the American) will try and penetrate continental markets for mergers and acquisitions, investment management, and the like, but increased alertness and rapid innovation on the part of major continental banks should make this far from being an obvious prospect.

Instead, we should be seeing each major country consolidating its banking activity in one *national* center which should serve as the "hub" for all the other minor commercial centers. This should be made possible by the increased use of technology in banking which should diminish the need for numerous regional banking centers *within* each country. Moreover, the telecommunications aspect of technology should gradually "bind" these national hub centers together on the European level (this will be a prerequisite for the growth of pan-European universal banks we discussed earlier). In other words, European financial integration should not mean the increased concentration of all banking activity in one or two European-level centers as is likely to be the case in the securities markets which tend to have a "wholesale" characteristic.

These structural developments have important implications for financial intermediaries. Building viable positions will require them to start with a assessment of where they stand *now* and what their short-term capabilities and competitive advantages can allow them to reach within the next decade. For instance, for a regional intermediary, it may turn out to be wiser to pursue a strategy of direct alliance in the form of a cooperative agreement with a "hub" center bank in its own country than trying to jump this step and embark on an acquisition strategy abroad.

Likewise, it may be more prudent for major national banks to develop better ties with smaller companies than try desperately to attract the debt-and-equity-new-issuance business of their major corporate clients whose needs in this particular area may be better met by London-based intermediaries. Similarly, brokers/dealers in London with excellent secondary market capabilities may be better off allying themselves with continental research firms for local advice and with continental brokers for local trades than trying to create "mini home offices" to duplicate their secondary market skills in less liquid continental markets. How well European financial intermediaries undertake this assessment of their capabilities in light of this evolving market structure will determine the winners from the losers in the integrated European financial markets of the 1990s and beyond.

VII. Conclusion

A fundamental evolution is taking place in Europe's financial services industry: twelve formerly independent markets ladened with twelve different historical experiences and developments are blending together to create one integrated financial sphere. In comparative terms, the final goal of this process goes far beyond what the U.S. or Japan have achieved to date in the financial arena. The expected financially integrated Europe will not only explicitly enable interstate banking, securities and insurance under home state supervision, but in tacit recognition of the blurring of traditional functional roles and the globalization of financial services, will permit financial intermediaries to freely adopt the universal banking structure of financial activities throughout the twelve EEC nations.

Considering the numerous differences in regulations, standards, informal attitudes and "practices" in each of these disparate financial markets, we have seen that January 1, 1993 will only serve as a symbolic marking point in a long and arduous process of integration which has already been characterized by fits and starts. In other words, participants in Europe's financial markets, ranging from financial intermediaries, securities exchanges, governments, corporations, investment funds to retail clients, may not see the true benefits of financial integration to them until well after 1993. Our examination of what these benefits may be indicates that they indeed are worth waiting for.

As financial intermediaries consolidate in type and in number at a European level, operationally inefficient and uninnovative banks and securities houses, financially viable only under protected circumstances will find themselves restructured in some form or another. The cross-shareholdings and strategic alliances that these players are now taking refuge under may nevertheless end up in outright mergers and acquisitions as financially healthier intermediaries with new "value-propositions" to the end-clients become bolder on the pan-European arena. And the buyers of their financial products will certainly gain from being served by more efficient and innovative intermediaries that will now be faced with competitive pressures at a European, rather than national level:

- Corporations should find themselves presented with a larger breadth of funding options either via financial intermediaries from across EEC countries or, increasingly, via tapping directly more dynamic national and European securities markets.

- Individuals, in addition to gaining from future efficient consumer loan markets, should also be able to choose from a panoply of investment opportunities on a pan-European level.
- Investment fund managers, in recognition of the fact that cross-border investments can reduce risks without lowering returns, will increasingly attempt to diversify their portfolios on a European and international level.
- European securities exchanges, most of which have remained stagnant backwaters of global financial markets, are already rising to the challenge of the new financial environment and are vying with each other to provide differentiated and operationally efficient trading arenas linked technologically to other European and international financial centers.
- Last, but not least, European governments, long used to playing a heavy-handed role in controlling (and in some cases, stifling) national financial markets, are awakening to the short-term cash benefits of privatization and to the longer term tax-income from profitable financial entities.

However, as we have indicated these enormous benefits of an integrated financial market may be neither equally distributed nor may they be expected without a price tag, i.e., the repercussions of structural readjustment to the respective participants. These are the anticipated side effects of the European Commission's voluntary "dynamic disequilibria."

To survive in this period, and better yet, to prosper, new skills will need to be acquired. Nevertheless, in the ensuing competitive turmoil, weak financial institutions may suffer and be absorbed by stronger, frequently non-local players. Uninnovative corporations, individuals, and investors used to viewing the bank as the only recourse for their financial needs will find that other buyers of such services have either reduced their funding costs or improved their risk-return profiles. And as capital flows freely to its most efficient destination within the EEC countries, individual governments will increasingly find national monetary control and government deficit financing a trickier task.

Yet, one should not view these transitory side effects as reasons for not going forward with the mandate for integration laid by the

European Commission. As aggressive and innovative participants already understand, the needed skills can be acquired, the pitfalls can be avoided, the challenges can be tackled, as the opportunities and the stakes are worth pursuing and defending.

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I. Introduction

Mortgage-backed securities (MBSs) are one of the most successful financial innovations of modern times. The Government National Mortgage Association (GNMA) created the first publicly traded, government-guaranteed, mortgage pass-through security in 1970. Today there are over $930 billion in federal agency pass-throughs outstanding, that is, agency pass-throughs account for more than a quarter of all outstanding mortgage debt.[1] Agency pass-throughs as a fraction of total mortgage originations, while quite variable, are higher still, indicating that pass-throughs will form an even larger share of outstanding mortgage debt in the future.

The popularity of federal agency pass-throughs is easy to explain. First, repayment of principal and interest is guaranteed by the issuing agency, hence default risk effectively is eliminated. Second, pass-throughs are liquid; there is a large and active secondary market in agency pass-throughs. However, mortgage pass-throughs suffer from one serious drawback: their cash flows (and, as a result, their yields) are erratic and unpredictable. Most mortgages can be prepaid without penalty at any time. When interest rates fall, as they did in 1986 and 1987, refinancings can dramatically accelerate the repayment rate of mortgage pass-throughs. To make matters worse, there is considerable heterogeneity in the prepayment behavior of otherwise identical pass-through securities. As a result, investors in pass-throughs are exposed to considerable risk.

This monograph examines the prepayment experience of mortgage pass-throughs issued by the Federal National Mortgage Association (FNMA). We analyze a virtually complete record of the paydown of all FNMA mortgage pools. To the best of our knowledge, this data set has not previously been analyzed in the academic literature and relatively few practitioner publications present detailed information on the behavior of FNMA pools. One of the principal contributions of this monograph is a careful description of the key factors of the FNMA pools. The second contribution of this monograph is a summary of the prepayment experience of the FNMA pools. This summary suggests ways in which the prepayment behavior of these pools might be modeled more formally.

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[1] Table 1.54 of the *Federal Reserve Bulletin* reports statistics on mortgage debt outstanding. The June 1990 issue of the *Bulletin* reported that agency mortgage pools outstanding accounted for $932 billion (26 percent) out of a total of $3,524 billion in outstanding mortgage debt in the second quarter of 1988.

The next section of the monograph briefly reviews some background information on FNMA and other federal housing agencies and on mortgage pass-through securities. The succeeding section describes the key factors of the FNMA pools. The following section summarizes the prepayment experience of the pools. The final section presents some concluding comments and suggestions for further research.

II. Background

A. GNMA, FNMA, and FHLMC

The three federal agencies most important to the mortgage-backed securities market are GNMA, FNMA, and the Federal Home Loan Mortgage Corporation (FHLMC).[2] While all three agencies are heavily involved in the mortgage pass-through market, there are subtle but important differences both in the focus of each agency's program and in the attributes of each agency's securities.

GNMA is a government corporation within the Department of Housing and Urban Development (HUD). In 1968, GNMA was created to assume the credit market support functions of FNMA and to exercise a new power, the authority to guarantee pass-through securities backed by Federal Housing Administration (FHA) and Veterans Administration (VA) mortgages. GNMA does not issue, buy, or sell any mortgage pass-throughs; it only insures mortgage pass-throughs. The formation and servicing of GNMA pass-throughs are handled for the most part through servicing agreements with FNMA and FHLMC.

The first GNMA pass-through was issued in 1970. By the end of 1971, over $3 billion dollars in GNMAs were outstanding. GNMA pass-throughs have been very successful; the outstanding balance of GNMA pass-throughs grew at an annual rate of 31 percent from 1971 through the end of 1989 when the outstanding balance stood at $375 billion. At the end of 1989,GNMA pass-throughs accounted for 44 percent of the total pass-throughs of the three agencies. This share actually reflected a decline in the dominance of the GNMA program.

FHLMC was created by the Emergency Home Finance Act of 1970 to establish a national secondary market for conventional (as opposed to federally guaranteed or insured) residential mortgages. The three members of the Federal Home Loan Bank Board (FHLBB) serve as the chairman and directors of FHLMC. All of FHLMC's stock was initially distributed to the twelve Federal Home Loan Banks. In 1981, preferred stock was issued and sold through the district banks to member savings institutions in proportion to their shareholdings in their regional Home Loan Banks. Thrifts were recently given the option to exchange their preferred shares, which can only be held by thrifts, for new preferred FHLMC shares which can be sold to anyone. The deadline for tendering the old shares was November 30, 1988.

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[2] This section is based in part on the description of the federal agencies in Lore (1987, esp. chap. 2). Other useful treatments of this material are found in Pierce (1984), Sellon and VanNahmen (1988), and Sullivan and Lowell (1988).

FHLMC calls its mortgage pass-throughs *Participation Certificates* (PCs). These securities, first issued in 1971, were the first pass-through securities for conventional mortgages. The balance of outstanding FHLMC pass-throughs has grown at an annual rate of 46 percent from the end of 1972 through the end of 1989 when the outstanding balance stood at $266 billion. That figure gave FHLMC a 31 percent share of total pass-throughs of the three agencies.

FNMA is the oldest of the three agencies; it was chartered by the FHA in 1938 to provide liquidity to the primary mortgage market. FNMA bought government-insured (FHA and VA) mortgages that were already on the books of savings and loan associations and other mortgage lenders for its portfolio. The initial capital stock for FNMA came from the Reconstruction Finance Corporation. FNMA obtained additional financing by issuing debt securities. These debt securities were claims on the government of the United States; they were *not* tied in any way to the mortgages in FNMA's portfolio.

FNMA's function in the mortgage market changed in the 1950s and 1960s. In 1954, the FNMA Charter Act established the agency as a mixed public/private corporation. At this point, FNMA became privately owned and financed[3] but retained the supervisory authority of the Housing and Home Finance Agency (now called the Department of Housing and Urban Development (HUD)). As was noted above, FNMA was broken into two corporations in 1968. GNMA took over the mortgage support functions of FNMA along with the authority to guarantee pass-through securities backed by FHA and VA mortgages. FNMA retained its mortgage purchase program and its existing portfolio of mortgages. FNMA also became somewhat more of a private corporation, although HUD continues to regulate FNMA and the President of the United States appoints five of the fifteen members of the FNMA Board of Directors.[4]

Prior to 1972, FNMA was authorized to purchase only FHA and VA-insured one-to-four family mortgage loans. Beginning in 1972, FNMA began to purchase conventional mortgage loans, and today conventional loans are the dominant asset in FNMA's purchase program. FNMA's presence in the mortgage market has made it the third largest corporation in the United States[5] with a mortgage portfolio totaling just over $110 billon.[6] This portfolio dwarfs the holdings of GNMA and FHLMC.[7]

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[3] FNMA's stock is traded on the New York Stock Exchange.

[4] The President also has the power to remove, for good cause, any member of the Board including members elected by the FNMA stockholders.

Despite being the oldest and having the largest mortgage portfolio of the three housing agencies, FNMA was the last of the three to enter the mortgage-backed securities market. The first FNMA MBS was issued in 1981. The balance of outstanding FNMA pass-throughs has grown at an annual rate of 47 percent from the end of 1982 through the end of 1989 when the outstanding balance stood at $217 billion. That figure gave FNMA a 25 percent share of the total pass-throughs of the three agencies.

In the few years since it entered the MBS market, FNMA has become an important player in this market. Table 1 presents annual data on the issues and amounts outstanding of FNMA mortgage pools from FNMA's first issue in November 1981 through it's 53,107th issue in June 1988.[8] Figures 1 and 2 display two measures of market share—mortgage pools as a share of total mortgage debt and as a share of all federal agency pools—for GNMA, FHLMC, and FNMA.[9] Issues of new FNMA pools doubled between 1984 and 1985 and again between 1985 and 1986. Issues of new pools peaked for all three agencies in 1986 reflecting the wave of refinancings that followed the drop in mortgage interest rates in early 1986. Nonetheless, FNMA's shares both of total mortgage debt and of the market for agency pools has continued to grow at the expense of the other two agencies. In addition, FNMA is now a leader in the development of new mortgage products with stripped MBSs and REMICs being two recent examples.[10]

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[5] The First Boston Corporation (1988), p. 94.

[6] Table 1.54 in the June 1990 issue of the *Federal Reserve Bulletin* reports FNMA's holdings of mortgage debt in the fourth quarter of 1990 as $110,970 million.

[7] Table 1.54 in the June 1990 issue of the *Federal Reserve Bulletin* reports GNMA's and FHLMC's holdings of mortgage debt in the fourth quarter of 1990 as $24 million and $22,289 million, respectively. The Farmers Home Administration and the Federal Land Banks held portfolios of $42,080 million and $30,788 million, respectively, during the same period.

[8] The total number of pools in Table 1 is only 53,093 because we do not have data on 9 pools and 5 pools were dropped from our sample because of data inconsistencies. Correspondingly, the dollar value of the pools also understates the actual dollar value, but by a negligible amount.

[9] The data in Figures 1 and 2 are the same as in the last two columns of Table 1, however the figures display quarterly figures while the table reports only the end of year figures. The figures also show the shares of the other agencies and of the sum of the agencies, while the table reports these figures for FNMA alone.

[10] Stripped MBSs are mortgage pass-throughs with two classes of securities. One class (the principal-only or PO) receives most or all of the principal payments while the other class (the interest-only or IO) receives most or all of the interest payments. See Becketti (1988) for a detailed explanation of stripped securities. The Tax Reform Act of 1986 created the Real Estate Mortgage Investment Conduit (REMIC) to overcome tax problems faced by collateralized mortgage obligations (CMOs) and other structured mortgage-backed assets. Lore and Kusma (1987) is a valuable reference on REMICs.

Table 1: FNMA Mortgage Pools Issued and Outstanding

	Pools issued*		**Pools outstanding†**	
	Number	Billions of dollars	Share of mortgage debt	Share of agency pools
1981‡	13	102	.05	.4
1982	1,260	1,473	.9	6.4
1983	2,940	1,246	1.4	8.4
1984	3,555	1,446	1.8	10.3
1985	8,503	2,684	2.4	12.5
1986	16,990	6,443	3.7	17.2
1987	15,914	5,836	4.8	19.5
1988§	3,918	2,345	5.2	20.7

* Source: *The Bond Buyer.* Includes all pools issued during the time period.

† Source: *Federal Reserve Bulletin.* As of the end of the time period.

‡ November-December only.

§ January-June only.

Figure 1: Agency mortgage pools as a share of total mortgage debt

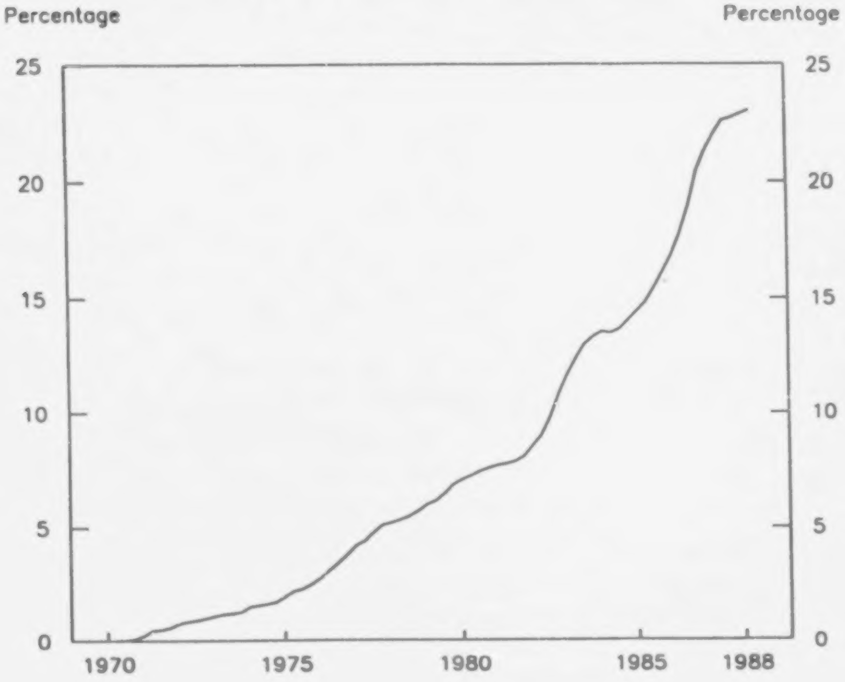
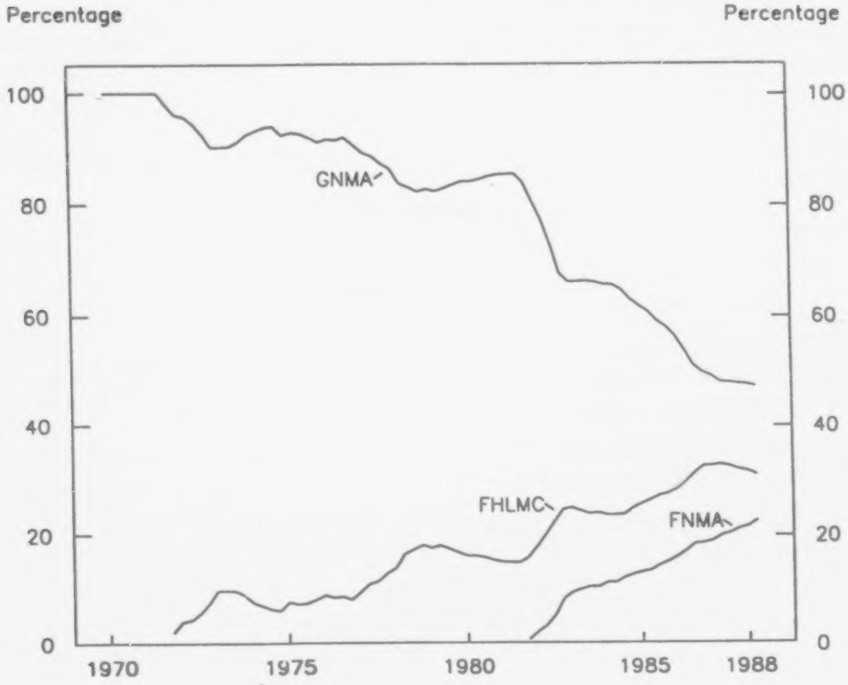


Figure 2: The market share of all agency mortgage pools



B. Mortgage-backed Securities

All mortgage-backed securities pool a large number of more or less similar mortgages and use these as the backing or collateral for the issue of a new and sometimes very different security. The simplest and most prevalent type is the pass-through security in which investors receive *pro rata* shares of the cash flows from the underlying pool of mortgages. Almost all mortgage pass-throughs are so-called modified pass-throughs, that is, investors are guaranteed to receive interest and principal payments even if mortgages are in default or delinquent.

Mortgage pass-throughs are more desirable assets than the individual mortgages underlying them. First, the pass-throughs are guaranteed against default and delinquency even if the individual mortgages are not. Second, the pass-throughs are liquid securities; individual mortgages tend to be very illiquid. Third, the eccentric and choppy prepayment patterns of the individual mortgages are smoothed by being pooled with many other mortgages. The relative attractiveness of the mortgage pass-throughs explains why investors will accept a lower yield on pass-throughs than on the underlying mortgages.

Mortgage pass-throughs have some features that make them less desirable than traditional fixed income securities, and these explain the development of alternative mortgage-backed assets. The most important of these disadvantages is the uncertainty in the term of the pass-through caused by the prepayment of the mortgages in the pool.[11] This uncertainty in the term (and, hence, the realized yield) of mortgage pass-throughs increases their riskiness to investors.

So-called structured mortgage-backed assets address the problem of prepayments by reshaping the cash flow from the mortgage pool. Mortgage-backed bonds are the simplest example; they are just traditional bonds that are collateralized with mortgages or mortgage pass-throughs. Collateralized mortgage obligations (CMOs) are a more complicated solution to this problem. They are also a form of mortgage-backed bond but with multiple classes of bond-holders. In this structure, some investors are entitled to the earliest principal payments while others receive principal payments only after other classes of investors are paid off.[12]

Despite these innovations, the most important mortgage-backed asset so far is the mortgage pass-through. The outstanding volume of pass-throughs greatly exceeds the outstanding volume of other mortgage-backed assets. In addition, mortgage pass-throughs are typically the collateral for other mortgage-backed assets. In the remainder of this monograph, we consider only mortgage pass-throughs.

C. Differences between Agency Pass-through Programs

There are several important differences between the mortgage pass-throughs of the three federal agencies. These differences include the nature of the agency guarantee, the types of mortgages that may be included in the mortgage pool, and the homogeneity of the underlying mortgages.

GNMA offers the strongest guarantee of the three agencies. GNMA guarantees full and timely payment of principal and interest including prepayments, and this guarantee carries the full faith and credit of the United States. FNMA also guarantees the full and timely payment of principal and interest including prepayments. FHLMC guarantees the full and timely payment of interest and the ultimate payment of principal. Neither FNMA nor FHLMC are government agencies; FNMA is a quasi-private corporation and FHLMC is a corporate instrumentality of the U.S. owned by the Federal Home Loan Banks and the member S&Ls. Thus the

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[11] A less important disadvantage, but one addressed by many of the newer mortgage-backed securities, is the monthly payment schedule of mortgages. Many investors prefer quarterly, semiannual, or annual payments, depending on the other assets and liabilities on their balance sheets.

[12] Typical CMO structures are explained in Hayre, Foulds, and Pendergast (1988).

FNMA and FHLMC guarantees *do not* carry the full faith and credit of the U.S. government. As a result, GNMAs are considered to have the highest credit quality, and they generally trade at a premium to other pass-throughs. Because FNMA's ties to the government are the loosest of the three agencies, its securities tend to trade at a discount to those of GNMA and FHLMC. Whatever their explicit legal status, market participants appear to believe that FNMA and FHLMC enjoy an implicit government guarantee against agency default. This belief explains why the debt securities of FNMA and FHLMC are invariably rated AAA by the private rating agencies despite balance sheets that would not support such a high rating for a private corporation.[13]

GNMA is restricted to insuring pass-throughs backed by mortgage loans insured or guaranteed by the FHA, the VA, or the Farmers Home Administration (FmHA). FNMA and FHLMC pass-throughs can be backed either by conventional loans or by seasoned FHA/VA loans.[14] This difference in the types of mortgages affects the prepayment experience of the pools. Conventional loans are generally due on sale while FHA/VA loans are assumable. In addition, the conventional loans can be larger than the largest allowed FHA/VA loan, although there are caps on the size of the conventional loans that FNMA and FHLMC can pool.[15] Both these differences tend to increase the average rate of prepayment of pass-throughs backed by conventional loans relative to FHA/VA pass-throughs.

GNMA pools are more interest-rate homogeneous than FNMA and FHLMC pools. Mortgages in the GNMA I program[16] all have the same interest rate which is 50 basis points over the pass-through rate, that is, the rate paid to investors in the pass-through securities.[17] Mortgages in the GNMA II program may have interest rates anywhere from 50 to 150 basis points over the pass-through rate. Mortgages in FHLMC Swap Program and FNMA pools may have interest rates from 50 to 250 basis points over the pass-through rate, and there are no restrictions on the interest rates of the mortgages in FHLMC Cash Program pools.[18]

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[13] For example, according to a recent FNMA annual report, stockholder equity at the end of 1987 was only 1.8 percent of assets, and this ratio reflects steady improvement. Equity was only 1.1 percent of assets at the end of 1985.

[14] As will be discussed in the next section, there is, in reality, a dizzying array of other types of mortgages that can be and are pooled by the three agencies. However, the outstanding balances of most of these other types of pools are very small in comparison to the balances of the primary types of pools issued by the agencies.

[15] The maximum size of loan that FHA will guarantee varies by region. In 1988, this maximum ranged from $67,500 to $101,250. VA has no upper limit on the size of the loan it will guarantee, however it guarantees only 40-50 percent of the loan and it will guarantee no more than $36,000. The FNMA/FHLMC cap on conventional loans is adjusted each year. In 1988, the largest conventional one-family residence mortgage loan permitted in these programs was $168,700 ($253,000 in Alaska and Hawaii).

[16] The original GNMA mortgage pass-through program is called GNMA I. The GNMA II program was established in 1983 primarily to take advantage of certain technological improvements that were not available in 1970. However, there are some substantive differences between GNMA I and GNMA II.

[17] Mobile home pools are treated differently in both GNMA I and GNMA II.

Since investors rarely know the characteristics of the individual mortgages in a pool, this interest rate heterogeneity makes it more difficult to predict a pool's future prepayments. Two pools with the same weighted average mortgage coupon rates may behave differently because the interest rates on the underlying mortgages are distributed differently.[19] In this regard, GNMA I securities are the easiest to analyze, because all the mortgages in a pool have the same interest rate.[20]

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[18] There are some complicated additional restrictions on some of the FHLMC pools.

[19] For example, consider a FNMA pool and a GNMA I pool with identical weighted average coupon rates (WACs) at the time of their formation. Imagine that the coupons in the FNMA pool are distributed throughout the 200 basis point band permitted in the FNMA program. All the mortgages in the GNMA pool have the same coupon rate. Over time, the mortgages in the FNMA pool that have the higher rates will tend to prepay more rapidly than the other mortgages in the pool. As a result, the WAC of the FNMA pool will tend to decrease over time. On the other hand, the WAC of the GNMA pool will never change. As the WACs of the FNMA and GNMA pools diverge, their prepayments will also diverge.

[20] There are additional margins (seasoning, remaining term, etc.) along which GNMA pools tend to be more homogeneous than FNMA and FHLMC pools. These differences between the programs are more difficult to summarize and are less directly related to prepayment experience. For more details, consult Lore (1987) or Sullivan and Lowell (1988).

III. FNMA Mortgage Pass-Throughs

This section catalogs some of the key characteristics of the FNMA mortgage pass-throughs. These characteristics play an important role, either directly or indirectly, in analyzing the prepayment behavior of the FNMA pass-throughs. The section begins with an overview of the *Bond Buyer* factor tapes which contain the data set we use.[21] Following this introductory material, there are subsections devoted to the distributions of mortgage types, the interest rates of the mortgages, the issue dates and age distributions, the sizes of the pools, and the location of the collateral and the originator/services of the pools.

A. The FNMA Factor Data

The Bond Buyer, a subsidiary of International Thomson Publishing Corporation, holds the distribution rights for all data on GNMA, FHLMC, and FNMA mortgage pools.[22,23] Data are available in a variety of forms: in reports, on-line, and on magnetic tape. For FNMA mortgage pools, four different magnetic tape series can be purchased. The pricing tapes report the closing market prices for each security. The geographic tapes list the state from which most of the mortgages in a pool come. The factor tapes report the outstanding principal balances for each of the pools. The ARM tapes contain additional information needed to evaluate the behavior of adjustable rate pools.

This monograph is based on the *Bond Buyer* factor tapes for FNMA since these tapes contain the information needed to calculate pool prepayment rates.[24] *The Bond Buyer* issues a new tape each month reflecting the monthly schedule of mortgage payments and pool servicer reports. This monograph is based on the tapes from April 1982 through June 1988.[25] Each month's tape contains the current *factor*, that is, the ratio of the outstanding principal balance to the original principal balance, for every FNMA pool still in existence. For each pool, the tape also reports the issue date of the pool, the identification number assigned by FNMA to the pool, the CUSIP number of the pass-through securities, the name and location of the lender/servicer, the pool prefix (a code that identifies the types of mortgages in the pool), the original principal balance of the pool, the pass-through rate (the interest rate paid to investors in the pass-through securities), the maturity date of the mortgage in the pool that matures last, and the weighted average mortgage coupon rate and maturity as of the issue date of the pool.

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[21] We would like to thank Franklin Savings Association, Ottawa, Kansas for providing us with the data.

[22] International Thomson also owns *American Banker.*

[23] Data on GNMA pools is also distributed by Chemical Bank which sells the data to a variety of retail vendors. One of these vendors, Financial Publishing Company of Boston, Massachusetts offers factor tapes for GNMA, FNMA, and FHLMC. FNMA has indicated that it is willing to provide some data directly.

[24] We are also in the process of analyzing GNMA and FHLMC factor tapes. The results of these efforts will appear in later papers.

[25] *Bond Buyer* began issuing the FNMA factor tapes in April 1982.

There is an enormous amount of data in the factor tapes. From the beginning of the FNMA MBS[26] program through June 1988, FNMA has formed 53,107 pools of which 52,596 are still active. The tapes contain 1,308,045 factor observations on these pools, and the number of observations is increasing rapidly.[27] Each of the active pools contributes a new factor observation each month, and the number of active pools has been growing by anywhere between 400 and 1900 pools a month in recent years. As a result, the number of factor observations is now increasing by close to 55,000 observations each month.

The first FNMA mortgage pass-through was issued in October 1981, but our factor observations do not begin until April 1982. Very little data is lost by this late start. Only 94 pools were issued before April 1982, and there were only 170 factor observations on these pools prior to April 1982. In other words, less than 0.02 percent of the factor observations are missing from the factor tapes.

B. The Types of Mortgages in the FNMA Pools

FNMA forms mortgage pools from many types of mortgages, however, each pool contains only one type of mortgage. In the factor tapes, each pool is coded with a two-letter prefix that indicates the type of mortgages in that pool. Table 2 lists the types of mortgages pooled by FNMA and their relative importance in the FNMA pass-through program.

As Table 2 shows, 21 different kinds of loans are pooled.[28] However, the majority of the pools are formed from a single kind of loan—

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[26] 'MBS' stands for 'mortgage-backed security'. Technically, an MBS is any asset backed by mortgages or mortgage-related assets, thus mortgage pass-throughs, mortgage-backed bonds, CMOs, and the like are all MBSs. However, the dominance and importance of pass-throughs has led many to use MBS as a synonym for mortgage pass-through securities. In any event, FNMA uses the term 'MBS' to denote its pass-throughs.

[27] After cleaning the data on these tapes, we were left with 1,307,752 factor observations on 53,093 pools of which 52,592 are still active. From this point on, we will refer to this cleaned data set as the universe of FNMA mortgage pools.

[28] FNMA's documentation defines 24 prefixes, but three of these have not been used so far.

Table 2: The Types of Mortgages in FNMA Pools

Fixed rate, level payment mortgages			
Prefix	Type of loan	Number of pools	Share of issues*
CL	Long term	38,069	61.2
CI	Intermediate term	10,267	12.0
GL	FHA/VA long term	1,017	7.0
CA	Long term assumable	280	0.2
ML	Long term multifamily	60	0.1
CS	Short term	3	0.0
	Subtotal	49,696	80.5

Adjustable rate mortgages			
Prefix	Type of loan	Number of pools	Share of issues*
AS	Single family	2,272	12.6
AM	Multifamily	166	1.6
VL	California variable rate	149	1.7
A2	Convertible to fixed rate†	32	0.0
AC	Convertible to fixed rate†	23	0.0
AX	Convertible to fixed rate†	3	0.0
	Subtotal	2,645	15.9

* Dollar-weighted share of all pools in percent as of June 1988.

† Mortgages in A2, AC, and AX pools differ in their convertibility dates and in their interest rate caps.

the conventional, long term, fixed rate, level payment mortgage. Seventy-two percent of all pools (38,069 out of 53,093) are of this type.[29] Table 2 also shows that, as of June 1988, the current dollar value of these pools still accounted for the largest share of the value of all pools outstanding. One surprising (at least to us) feature reported in Table 2 is the large proportion of conventional, intermediate term pools. These are composed of mortgages

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[29] As indicated in this sentence in the text, this 72 percent is the number of pools with the 'CL' prefix divided by the total number of pools. The first line of Table 2 reports the share of 'CL' pools as 61.2 percent. This latter figure is the dollar value of outstanding 'CL' pools as of June 1988 divided by the dollar value of all outstanding pools at that date.

Table 2: The Types of Mortgages in FNMA Pools (cont.)

Other kinds of mortgages			
Prefix	Type of loan	Number of pools	Share of issues*
AB	Alaska Housing convertible growing equity (GEMS)	339	0.7
MX	Multifamily balloon	269	0.6
RL	Reverse buy-down	42	0.0
GC	Single family graduated payment	41	0.0
C4	GEMs with 4% annual payment increases	22	0.0
GG	Government graduated payment single family	21	1.9
C3	GEMs with 3% annual payment increases	12	0.0
MA	FHA/VA project loans	4	0.2
MI	Convertible intermediate term level payment multifamily	2	0.1
	Subtotal	752	3.5

* Dollar-weighted share of all pools in percent as of June 1988.

that mature in fifteen years or less. Nineteen percent of all pools (10,267 pools) are of this type. And as of June 1988, Table 2 shows that these pools accounted for a relatively large 12 percent of the current dollar value of all pools outstanding.

In examining prepayment experience, we restrict our attention to four types of fixed rate, level payment pools: CL (conventional, long term), CI (conventional, intermediate term), GL (FHA/VA long term), and CA (conventional, long term, assumable). These four categories contain 93 percent (49,633) of the pools, and 80 percent of the total outstanding balance in June 1988. We call this subject of the FNMA pools the *Fixed Rate subset.* Unless otherwise noted, the data reported in the remainder of this monograph pertains to only the Fixed Rate subset.

We restrict our attention to the Fixed Rate subset for three reasons. First, it is difficult or impossible to calculate prepayment rates for many of the other pools from the data on the factor tapes. Second, it is likely that the prepayment behavior of the other pools differs systematically from the behavior of the Fixed Rate subset. Third, even if there are common features in the prepayment behavior of the eliminated pools and the Fixed Rate subset, the relatively small quantity of data in the eliminated pools indicates that little information is lost.[30]

C. Pass-through Rates and Coupon Rates

Probably the most important determinant of prepayments is the difference between the current mortgage interest rate and the *coupon rate,* that is, the rate of interest on the existing mortgage. When the current rate drops, refinancings and home sales increase, hence prepayments increase. When the current rate rises, refinancings and home sales decline, hence prepayments decline.

Reports on the performance of mortgage-backed securities tend to group pools by their pass-through rates. For GNMA pools, this practice causes no problems because all the mortgages in a pool have the same coupon rate which is fifty basis points higher than the pass-through rate.[31] In contrast, mortgages in FNMA pools need not have identical coupon rates, and these rates may lie anywhere from 50 to 250 basis points above the pass-through rate. Thus it is important to distinguish between a pool's pass-through rate and its weighted average coupon rate when analyzing the prepayment behavior of a FNMA pool.

For the Fixed Rate subset, the difference between the weighted average coupon (WAC) and the pass-through rate averages 72 basis points with a standard deviation of 28 basis points.[32] The smallest difference is 25 basis points (38 pools), and the largest difference is 250 basis points (32 pools). The modal difference is 50 basis points (18,576 pools). The difference is less than 50 basis points for 1,331 pools.[33] The difference is greater than or equal to 200 basis points for 280 pools.

Investors care both about a pool's pass-through rate and about the weighted average coupon of the mortgages in the pool. The pass-through rate is the same as the coupon rate on a regular fixed-income security—it tells the investor what the cash flow of the interest payments will be in the absence of prepayments. However, prepayments do alter the cash

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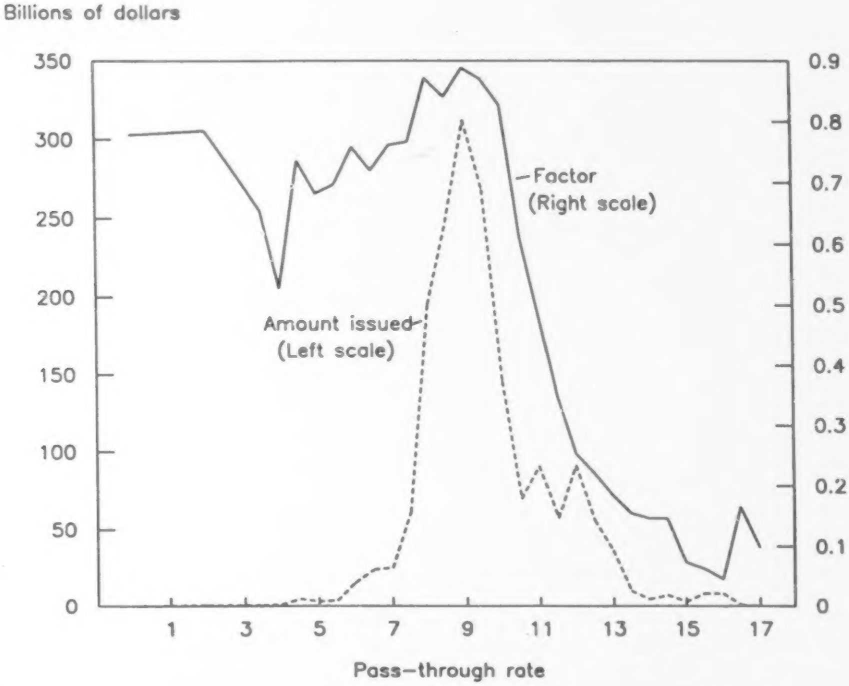
[30] The Fixed Rate subset does not include all fixed rate pools, but the few that are excluded are subject to one or more of the three objections noted in the text.

[31] This is strictly true only for the GNMA I program. See section II.3 above for more details on the differences between the agencies in restrictions on the within-pool distribution of interest rates.

[32] This is the standard deviation across pools. We have no information on the within-pool distribution of mortgage rates.

[33] The lender/servicer and FNMA may, and sometimes do, negotiate away up to 25 basis points of the FNMA guarantee fee. In these cases, the difference between the WAC and the pass-through rate can fall to as low as 25 basis points.

Figure 3: FNMA MBSs issues and factors by pass-through rate

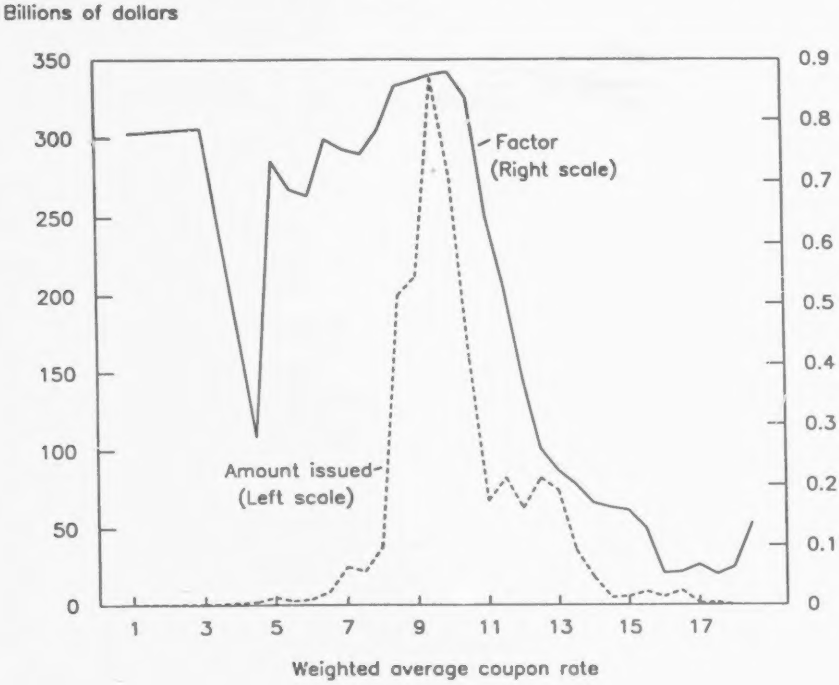


flow stream and, therefore, the expected yield on the MBS. Investors care about the WAC precisely because it is the difference between the current mortgage rate and the WAC, *not* the pass-through rate, that is the most important determinant of prepayment rates.

Figure 3 displays the amount of FNMA pass-throughs issued and the factor (percent outstanding) by pass-through rate for the Fixed Rate subset. The chart shows that relatively few high pass-through rate pools have been issued and only small fractions of those pools are still outstanding. Although relatively few low pass-through rate pools have been issued as well, large fractions of those pools are still outstanding. Figure 4 displays the same information for weighted average coupon rates. Given the close relationship between pass-through rates and WACs, it is not surprising that Figure 4 looks much the same as Figure 3.

Table 3 summarizes the data in Figure 4 and provides additional information on the pools in each WAC category. The first line of the table shows the number of pools in each WAC category. As expected, the majority of the pools have WACs between 8 and 12 percent. Surprisingly, 20 percent have WACs equal to or greater than 12 percent. The second line shows the original weighted average maturity (WAM) of the mortgages in the pools within each WAC category. The below-8 percent category has the

Figure 4: FNMA MBSs issues and factors by weighted average coupon



mortgages with the shortest original maturities and the over-12 percent category has the mortgages with the longest original maturities. The third line shows the weighted average age of the mortgages in the pools within each WAC category.[34] As expected, pools with WACs less than 8 percent are the oldest with an average age of 18 years and 2 months. The average age then falls dramatically to 6 years and 4 months for the pools with WACs equal to or greater than 12 percent. The dollar value of the pools at issue date, shown in line 4 of Table 3, is consistent with the number of pools data. Pools in the 8 to 12 percent categories have the largest amounts, and the over-12 percent category accounts for 18 percent ($3,118 billion) of the total amount issued. The 8 to 12 percent categories also have the largest outstanding balances as of June 1988 (line 5). The over-12 percent category, however, accounts for only 6 percent of the total outstanding balance, which is a third of its share of the amount issued. The decline in the over-12 percent category's dollar share between issue date and June 1988 is reflected in its current factor (line 6 = line 5/line 4). The over-12 percent category has by far the smallest factor among the four WAC categories.

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[34] The sum of the WAM and the age is less than 360 months because intermediate term mortgages are included in the sample.

Table 3: The Distribution of Weighted-average Coupons

	Weighted average coupon			
	< 8%	8%-10%	10%-12%	≥ 12%
Number of pools	1,061	20,054	18,475	10,043
Average maturity*	168	288	313	324
Average age†	218	56	37	76
Amount issued‡	670	7,887	5,827	3,118
Outstanding balance§	494	6,773	4,600	757
Current factor¶	.74	.86	.79	.24
Survival factor‖	.83	.93	.81	.27

* Months at issue date, weighted by original balance.

† Months, weighted by outstanding balance as of June 1988.

‡ Billions of dollars.

§ Billions of dollars as of June 1988.

¶ Outstanding balance divided by amount issued.

‖ Outstanding balance divided by balance scheduled in June 1988 according to the original amortization schedule.

The current factor declines over time for two reasons. First, the factor is scheduled to decline according to an original amortization schedule that depends on the pool's WAC and original WAM. In other words, the factor declines as the principal is paid down. Prepayments are the second reason the factor falls; prepayments reduce the principal balance faster than originally scheduled.

A high prepayment rate, not amortization, is the primary reason the pools in the over-12 percent category in Table 3 have the smallest factor. These pools are not very old (line 3), and they have the longest original WAM (line 2), thus very little of their principal is scheduled to have been repaid so far.[35] According to the amortization schedule, the pools in the 8 percent category should have the smallest factor, because they are far and away the oldest pools. Thus the decline in the factor for the over-12 percent pools must be due to faster prepayments.

Line 7 of Table 3 shows the prepayments are largely responsible for the decline in the over-12 percent category's factor. The survival factor at each point in time is the share of the *originally scheduled balance* that is still outstanding, which implies that one minus the survival factor is the share of mortgages that have prepaid since issue date.[36] The weighted average survival factor for the over-12 percent category is 0.27. That is, on average, 73 percent of the mortgages in the pools in the over-12 percent category have prepaid. Line 7 also shows that prepayments in the other categories have been much smaller than in the over-12 percent category. And these results are exactly as one would expect. As mortgage rates declined from the heights of the early 1980's, borrowers with high rate mortgages—those in the over-12 percent category—payed off their original mortgages and refinanced at lower rates. On the other hand, borrowers with lower rate mortgages have had less incentive to prepay.

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[35] For a given WAC, the scheduled factor increases as the original WAM increases. Although the WAC also affects the scheduled factor, the WAM effect dominates the WAC effect.

D. The Age Distribution of FNMA Pools

After interest rates, one of the most important factors affecting the prepayment rate of a mortgage pool is the age of the underlying mortgages. Older mortgage pools tend to have more stable prepayment rates than younger pools. A mortgage pool is said to be *seasoned* when it reaches an age such that its prepayment rate is constant, other things (especially interest rates) being constant.[37] Thus, when analyzing prepayments, it is important to know the extent to which the mortgages are seasoned. For example, if all pools were formed with seasoned mortgages, then the ages of the pools will appear to have no effect on prepayment rates.[38]

Table 4 shows the distribution of mortgage ages in the Fixed Rate subset as of the issue date of the pool for each of the years in which FNMA issued pass-throughs.[39] The majority of pools had an average age less than 5 years at the time of issue in every year. The second highest age category in every year except 1987 is 5 to 9 years. And except for 1982, the share of pools with average age below 5 years was over twice the share of pools with an average age between 5 and 9 years. The next-to-the-last line of Table 4 shows the distribution of mortgage ages at issue date for the aggregate of all issue dates, that is, it shows the marginal distribution of age at issue date. Just under 75 percent of the issues had an average age less than

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[36] If a is the age of a pool and S is the survival factor, then $1-S^{1/a}$ is the pool's average periodic prepayment rate since issue date.

[37] For an individual mortgage, this statement can be formalized in terms of the hazard function. Let $\lambda_t(x_i)$ be the hazard of mortgage i in period t, that is, the probability that the i - th mortgage prepays (terminates) in month t. x_{it} is a vector of variables, such as interest rates and location of collateral, that shift the hazard function. The i - th mortgage is seasoned when $\partial\lambda_t(x_i)/\partial t = 0$.

[38] In a regression context, the age effect will be captured by the constant.

[39] Since we have almost no information on the within-pool distributions of pool characteristics (including age), Table 4 actually reports the weighted average ages of the mortgages in the pools where the weights are the outstanding balances of the pools. Likewise, the weighted averages of other pool characteristics are reported in the other tables in this paper.

5 years, while only 3.2 percent of the pools had an average age equal to or greater than 15 years. Although it is not reported in Table 4, out of the 49,633 pools in the Fixed Rate subset, only 1,289, or 2.6 percent, had an average age equal to or greater than 15 years at issue date. The last line of Table 4 shows the distribution of mortgage ages in the Fixed Rate subset as of June 1988, our most recent observation. In other words, this line displays the marginal distribution of current age. This line shows that the majority of pools still have an average age less than 5 years, and that only about 6 percent have an average age of 15 years or more. That is, only a small share of the pools are seasoned.

Table 4: Age at Issue Date (in percent)

	Age in years						
Year of issue	0-4	5-9	10-14	15-19	20-24	25-30	Number
1981*	87.3	12.7	0.0	0.0	0.0	0.0	13
1982	50.4	42.6	6.4	0.5	0.1	0.0	1,238
1983	73.8	18.6	5.6	1.7	0.3	0.0	2,929
1984	58.8	27.0	9.4	4.1	0.7	0.0	3,273
1985	67.8	18.8	9.0	3.3	1.1	0.1	7,916
1986	73.8	16.2	6.3	3.1	0.6	0.1	16,349
1987	83.8	5.2	7.9	2.0	1.0	0.04	14,933
1988†	88.9	6.4	2.6	1.0	0.9	0.1	2,982
All issue dates	74.5	15.5	6.9	2.4	0.7	0.1	49,633
As of June 1988	61.2	17.7	15.3	4.2	1.4	0.2	49,332

Percentages are weighted by the original balance of the pools except for the last row which is weighted by the outstanding balance in June 1988.

* November-December only.

† January-June only.

E. The Size Distribution of FNMA Mortgage Pools

Pool size is another factor that could affect a pool's prepayment rate. Large pools should be more diversified than small pools because the large pools generally contain more mortgages, as opposed to larger mortgages, than small pools. The diversity of a large pool should reduce the idiosyncratic behavior of its prepayment rate relative to a smaller sized pool.

Table 5 shows the size distribution of FNMA pools. Fifty seven percent, or 28,024, of the Fixed Rate subset pools contained between $1 million and $2 million in mortgage balances at their issue date, while another 37 percent, or 18,402, had between $2 million and $10 million in mortgage balances at issue date. The average size at issue date of a pool in the Fixed Rate subset was $3.5 million.

Table 5: Size Distribution of FNMA Pools

Size	Number	Share*
under $1 million	1,073	2.2
$1—under $2 million	28,024	56.5
$2—under $3 million	8,005	16.1
$3—under $4 million	3,688	7.4
$4—under $5 million	2,392	4.8
$5—under $6 million	2,159	4.3
$6—under $10 million	2,158	4.3
$10—under $20 million	1,351	2.7
$20—under $100 million	619	1.2
$100—under $250 million	128	0.3
$250—under $500 million	32	0.1
$500 million and over	4	0.0
All sizes	49,633	—

* Number of pools in size category divided by number of pools of that type.

F. The Location of the Collateral and Pool Originators/Servicers

One factor which many observers believe affects prepayment rates is the location of the collateral.[40] Weak economic conditions in a state may increase foreclosures, at least temporarily. High mobility in a state may increase the rate of resales, perhaps permanently. The ten states with the largest dollar volume of FNMA pass-through issues are (in order) California, New York, Massachusetts, Florida, Texas, Illinois, Pennsylvania, New Jersey, Ohio, and Missouri. Table 6 displays the number of FNMA pools issued by these states, the original balances of these pools, the shares these issues represent, the outstanding balances of these pools, and the shares these balances represent.

Table 7 shows the largest originator/services of FNMA pass-throughs according to market share in the 12 month period from July 1987 to June 1988. Ninety-seven pools, or only about 1 percent of all pools, were multiple pools, but these pools accounted for one-third of the value of all pools issued in that 12 month period. Citibank/Citicorp was by far the largest single originator/servicer with an 8.1 percent market share. Excluding the multiple pools, Citibank/Citicorp had a 12.2 percent market share.

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[40] The *Bond Buyer* factor tapes reports the location of the originator/servicer. The mortgages need not, and do not always, come from the same state as the originator/servicer. Waldman, Peltz, and Lowen (1984, 1985) have estimated that, for FNMA and FHLMC pass-throughs, assuming that the mortgages in a pool come from the same state as the originator/servicer correctly classifies 85 to 90 percent of the mortgages.

Table 6: The Distribution of Pools by State

State	Number of pools	Original balance*	Share†	Outstanding balance‡	Share†
California	6,311	26,580	15	17,800	14
New York	3,935	11,910	7	9,165	7
Massachusetts	4,214	10,780	6	7,170	6
Florida	2,701	8,655	5	6,072	5
Texas	3,514	8,538	5	6,468	5
Illinois	3,128	8,421	5	6,159	5
Pennsylvania	2,722	7,023	4	5,261	4
New Jersey	2,214	5,716	3	4,612	4
Ohio	1,776	5,036	3	3,738	3
Missouri	1,208	4,526	3	3,596	3

* Millions of dollars.

† Row balance as a percent of the balance for all issues.

‡ Millions of dollars as of June 1988.

The next largest servicer was the Philadelphia Savings Fund Society, which had a much smaller 2.5 percent share (3.8 percent excluding multiple pools). The 10 largest originator/servicers accounted for 21 percent of the total market, and 31 percent of the market excluding multiple pools.

Table 7: The Top Originator/Servicer, July 1987-June 1988

Servicer	Number of pools	Value of pools*	Share†
Multiple pools			
Multiple pools	70	535	17.1
FNMA portfolio	27	510	16.3
Single servicers			
Citibank/Citicorp	300	255	8.1
Philadelphia Savings Fund Society	73	79	2.5
Barnett Mortgage Co.	91	56	1.8
Home Savings of America	82	42	1.3
Sears Mortgage Corp.	217	41	1.3
BankAtlantic	107	40	1.3
Commonwealth Mortgage Co. Inc.	133	39	1.2
Security Pacific National Bank	66	36	1.1
Bank of America	40	31	1.0
Commonwealth Mortgage Co. of America	144	29	0.9
Total	7,945	3,133	100.0

* Billions of dollars.

† Value as a percent of the value of all issues.

IV. The Prepayment Experience of FNMA Mortgage-Backed Securities

This section summarizes the prepayment experience of the Fixed Rate subset of FNMA pools. The first subsection defines prepayments. The second subsection examines three of the most striking characteristics of prepayment rates: the rapid changes in average prepayment rates in recent years, the variability in the pattern of prepayments across individual pools, and the shape of the distribution of prepayments across all pools and time periods. The third subsection describes in detail the relationship between prepayment rates and observable features of the FNMA pools. The fourth subsection discusses pools that tend consistently to prepay more or less rapidly than average.

A. Prepayment Calculations

This subsection briefly defines the prepayment concepts used in this monograph. A more complete set of prepayment calculations is provided in Appendix A.

The basic prepayment concept used in this monograph is the monthly *conditional prepayment rate* (CPR), which is also called the *single month mortality rate* (SMM).[41] The adjective 'conditional' in CPR indicates that it measures the current period's prepayment rate conditional on all past prepayments, that is, relative to the actual balance at the beginning of the month rather than the balance specified in the original amortization schedule.

Formally, let B_t denote the actual balance at the end of month t. Let $\tilde{B}_t$ denote the *conditionally* scheduled balance at the end of month t, that is, the balance that, conditional on B_{t-1}, would occur in the absence of any prepayments in month t. If, in fact, there are no prepayments in month t, then these two balances will be equal, that is, $\tilde{B}_t = B_t$. Otherwise, $\tilde{B}_t - B_t$ measures the dollar amount of the prepayments in month t. Let ρ_t be the rate of prepayment in month t, that is, the CPR in month t. Then

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[41] Some writers use 'SMM' to denote the periodic, that is, monthly rate of prepayment and reserve 'CPR' to denote the annualized SMM. We report only periodic prepayments and we use 'CPR' and 'SMM' interchangeably.

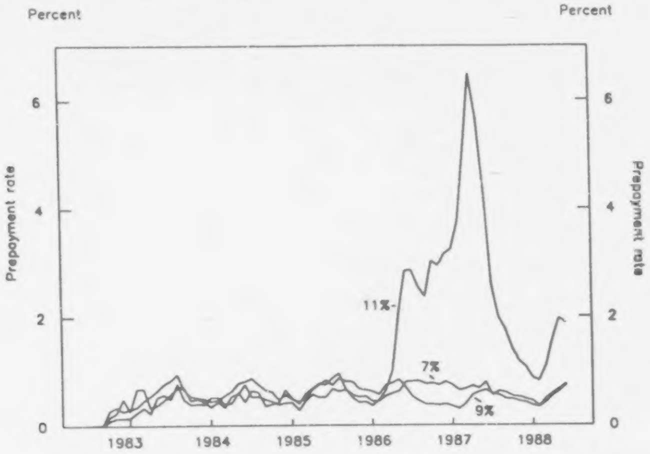
$$\rho_t = \frac{\tilde{B}_t - B_t}{\tilde{B}_t} .$$

B. The Three Main Features of Prepayments

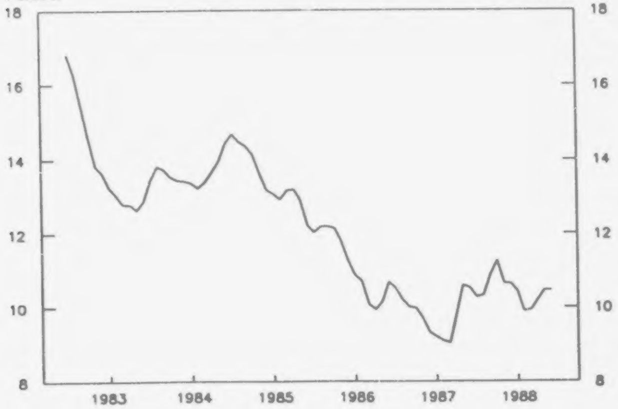
There are three particularly striking features of the prepayment experience of the FNMA pools. First, the average rate of prepayment has changed rapidly over time. Second, individual pools have idiosyncratic patterns of prepayments. Third, the distribution of prepayment rates is divided into two parts: there are no prepayments in more than two-thirds of the observations, and prepayment rates tend to be very small in the rest of the observations.

The most important fact about prepayment rates in recent years is how rapidly they have changed. Figure 5 displays the average pre-

Figure 5: Average prepayment rates for FNMA 7s, 9s, and 11s

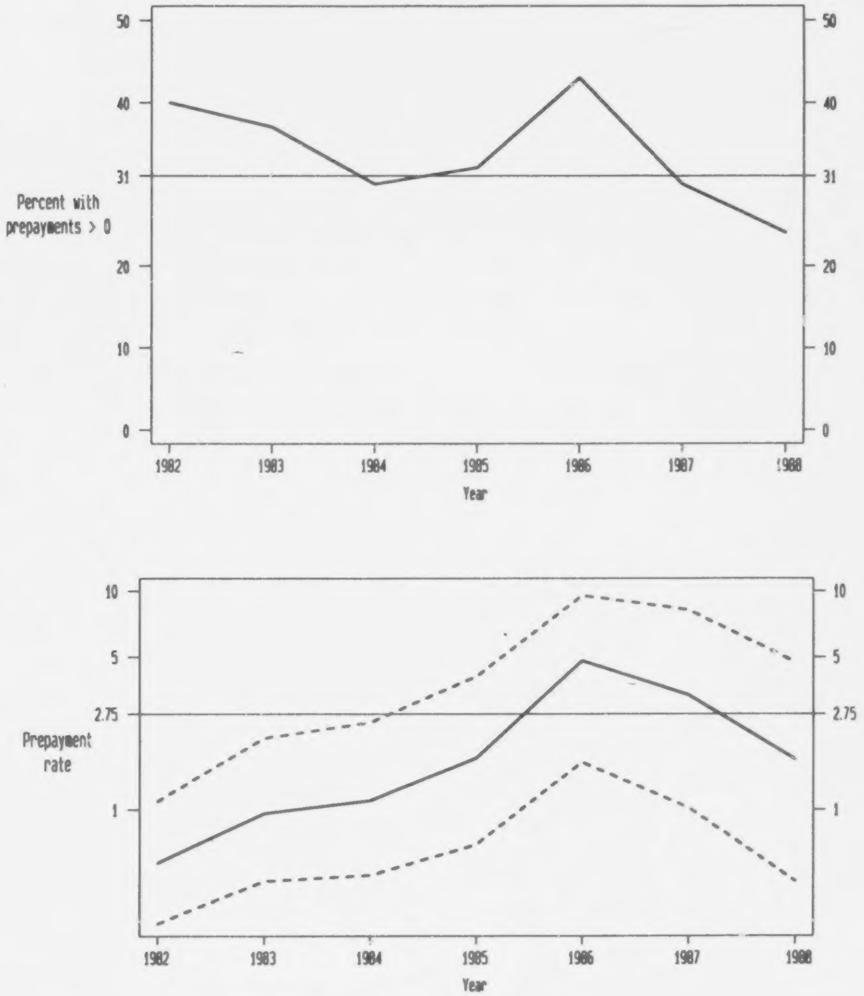


Mortgage rates



payment rates for FNMA mortgage pools with three different pass-through rates along with the interest rate on new mortgages from July 1982 through June 1988. The prepayment rates for all three pass-through rates remained fairly stable through 1985. In 1986, however, as mortgage interest rates fell below 11 percent, the prepayment rate for the 11 percent MBSs rose sharply. For example, in February 1986 prepayment rate on FNMA 11s was 0.5 percent. The prepayment rate then rose to 0.7 percent in March, 1.0 percent in April, and 2.1 percent in May. As mortgage rates continued to fall in 1986, prepayment rates on FNMA 11s continued to rise, peaking at 6.5 percent *per month* in April 1987. On the other hand, the prepayment rates for the 7 percent and 9 percent MBSs were basically flat over the

Figure 6: Prepayment rates and year



entire time period. This difference reflects the greater economic incentive to refinance the mortgages in the 11 percent MBS pool.

Figure 6 collapses the distinctions between pools with different pass-through rates and shows how prepayments changed over the sample period for all the pools. Table 8 displays the data used in constructing this figure along with other statistics. The top panel of the figure shows the percent of the observations with prepayments in each year. A horizontal line is drawn on the chart to highlight the fraction (31 percent) of all observations in the sample with prepayments. The fraction of observations with prepayments peaks in 1986 at 43 percent. By the first six months of 1988, this fraction drops to 24 percent, somewhat lower than the mean for the entire sample period.

The bottom panel of the figure displays the prepayment rate for the subsample with prepayments. Prepayment rates are shown on a ratio scale.[42] The solid line displays the median prepayment rate as a function of the year. The dashed line flanking this line indicate the 25th and 75th percentiles of the prepayment rate as a function of the year. Again, a horizontal line is drawn on the chart to highlight the median prepayment rate (2.75 percent) of the entire subsample with prepayments. Again, 1986 marks the peak in the median prepayment rate (4.79 percent), and this rate drops to 1.70 percent, below the overall median, in the first six months of 1988. Although lower than in 1986, the median prepayment rate in the first six months of 1988 is still about three times the median prepayment rate in 1982.

The second important aspect of prepayment rates cannot be seen in Figures 5 and 6; that is the variety of prepayment patterns across pools. Table 9 lists the prepayment rates for five different 13 percent MBS pools along with the average prepayment rate for all 13 percent MBS pools for the 18 months from January 1987 through June 1988. Note the diversity of behavior among these pools both over time and at a point in time. For example, in May 1987, when the average prepayment rate of 13 percent MBS pools was 6.3 percent, three of the five pools listed had no prepayments at all. The other two pools had prepayment rates of 19.8 percent and 2.4 percent. Pool C had no prepayments over the entire time period, while Pool E had significant prepayment rates in all but two months. Note that the prepayment behavior of none of the five pools looks like that of the 'average' FNMA 13. For the 18 months listed in Table 9, Pool C appears to be a 'slow pay pool,' a pool with chronically below-average prepayments.

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[42] The log transformation appears to roughly stabilize the variance of the prepayment rate as a function of any of the observables. As an aid in choosing an appropriate transformation, numerous spread-versus-level plots were constructed, and these all indicated the usefulness of the log transformation. See Emerson (1983) and Emerson and Strenio (1983) for a discussion of transformations and of the spread-versus-level plot.

Table 8: The Distribution of Monthly Prepayment Rates by Year

				Statistics for sample with $\rho > 0$					
Year	Mean	Percent with $\rho > 0$	Number with $\rho = 1$	25th percentile	Median	Mean	75th percentile	Inter-quartile range	Number of observations
1982	.47	40	0	.30	.57	1.18	1.09	.79	3,031
1983	.72	37	6	.47	.96	1.97	2.13	1.66	28,522
1984	.62	30	0	.50	1.10	2.05	2.51	2.01	62,383
1985	1.00	32	9	.69	1.73	3.10	4.06	3.37	117,592
1986	2.96	43	51	1.65	4.79	6.92	9.54	7.89	248,723
1987	1.87	30	164	1.02	3.34	6.27	8.20	7.18	461,277
1988*	.97	24	75	.47	1.70	4.13	4.73	4.26	283,098
1982-88	1.70	31	305	.87	2.75	5.41	7.09	6.22	1,204,626

All statistics in percent except the numbers of observations.

* January-June only.

Table 9: Prepayment Rates for Five Different FNMA 13s
(in percent)

Date		Pool					All
		A	B	C	D	E	FNMA 13s
1987	January	0	0	0	0	5.4	6.1
	February	0	13.3	0	12.3	4.1	5.0
	March	0	16.5	0	0	1.9	6.0
	April	23.6	0	0	0	8.3	6.1
	May	19.8	0	0	0	2.4	6.3
	June	0	0	0	17.7	3.8	6.2
	July	0	0	0	0	2.2	4.7
	August	28.7	0	0	0	2.4	4.0
	September	0	0	0	0	1.4	4.3
	October	0	0	0	0	6.3	3.1
	November	0	0	0	0	0.5	2.7
	December	0	0	0	0	2.5	2.4
1988	January	0	0	0	0	0	2.1
	February	18.0	0	0	0	0.7	1.9
	March	0	0	0	0	8.2	2.2
	April	0	0	0	20.4	0	2.4
	May	35.6	0	0	78.5	2.0	3.3
	June	0	0	0	0	5.3	3.5
Jan. 1987-June 1988		6.4	1.6	0	6.0	3.2	4.0

All pools are conventional, long term mortgage pools.

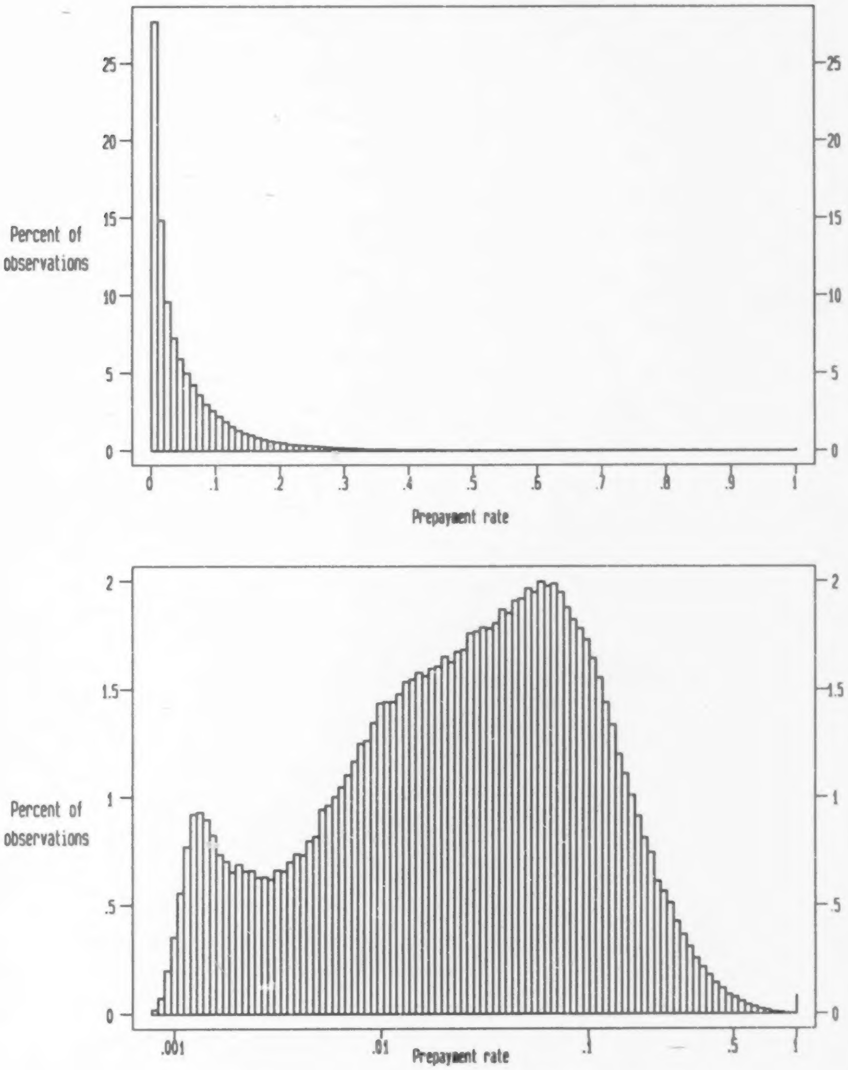
Over the same period, Pool A appears to be a 'fast pay pool,' a pool with above average prepayments, although Pool A had no prepayments in 10 of the 18 months.

The distribution of monthly prepayment rates has an unusual form. There are no prepayments in most of the observations (69 percent). In the remaining observations, the distribution of prepayments is concentrated near zero, and the fraction of the sample falls very rapidly as the prepayment rate increases. The majority of prepayments appear too small to be the result of the payoff (by refinancing, sale, or default) of one of the mortgages in the pool. Instead, these *partial prepayments* apparently are caused by, say, one or two mortgagors making double payments in a given month.

Figure 7 displays the distribution of prepayment rates for the 31 percent of observations with prepayments. The bottom panel shows the distribution of the log of these prepayment rates. The distribution after the log transformation is more nearly symmetric, but there are still more observations to the left, than to the right, of the mode.

This distribution of monthly prepayments raises questions about the appropriateness of many traditional methods of statistical

Figure 7: The distribution of monthly prepayment rates for those observations with prepayments



analysis. For the purposes of this monograph, it was desired to avoid making strong distributional and functional form assumptions in favor of reporting, as neutrally as possible, what the data 'say'. It turned out to be most convenient to characterize the distribution of payments and the relationships between prepayments and other variables by reporting both the fraction of observations with prepayments and the order statistics of the subsample with prepayments.

C. The Factors Influencing Prepayments

Prepayments occur when homeowners decide to refinance a home, to sell a home that has a nonassumable mortgage, or to default on a mortgage.[43] Thus the factors that influence these three decisions also influence the rate of prepayments. While many different factors can influence the decisions to refinance, relocate, or default, the most important factors appear to be the *relative coupon*, the difference between the current rate on new mortgages and the interest rate on the existing mortgage, and the age of the mortgage, and these two variables appear to have a stronger effect on prepayments than other observable variables.

This section documents the relationship between observable variables and the distribution of mortgage prepayments. First, the bivariate relationship between each observable and prepayments is analyzed. Next, the explanatory power of the variables and selected combinations of variables is measured. Special attention is focused on the ability of the combination of age and relative coupon to explain prepayments. Finally, the ability to capture the effects of age and relative coupon with a lower-dimensional model is assessed.

Relative coupon

The factor that appears to have the greatest effect on a pool's prepayment rate is the relative coupon.[44] The relative coupon is defined here as the current rate on new mortgages minus the pool's WAC. An increase in the current mortgage rate increases a pool's relative coupon, while a decrease in the current rate decreases a pool's relative coupon. Changes in the relative coupon are primarily due to changes in mortgage rates.[45]

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[43] Partial prepayments are simply partial refinancings. For example, cash-constrained households may apply some portion of the occasional bonus or other windfall to ward an accelerated paydown of their mortgage. These partial prepayments avoid the transactions costs of refinancing. However, the financial incentives for partial and complete refinancing should be the same.

[44] The evidence for this statement is presented later.

[45] The WAC can also change over time because as the mortgages in a pool prepay, the relative weights on the coupons in the pool also change. We only have data on the original WAC of each pool, however, so changes in the relative coupon reported here are solely due to changes in mortgage rates. Although we do not know how WACs change over time because we do not have the data, presumably the variation in WACs is small compared to the variation in mortgage rates. We have run simulations that indicate that even large measurement errors in the WACs would produce only very modest changes in the apparent prepayment rates.

The relative coupon affects prepayment rates primarily through the decision to refinance. If the interest rate charged for new mortgages is higher than the rate on the existing mortgage, the mortgage borrower has no reason to refinance at all. As the current mortgage rate begins to fall below the rate on the existing mortgage, the borrower would be better off with a mortgage at the new rate. However, the points and other fees charged to originate a new mortgage will outweigh modest differences in the interest rates. When the current rate falls far below the rate on the existing mortgage, the reduction in interest payments exceeds the fees paid to originate a new mortgage. Thus, refinancings increase when mortgage rates fall, and they increase more the greater the fall in mortgage rates.

Since the relative coupon for a given pool only changes when the mortgage rate changes, the relative coupon may also capture the effect of interest rate changes generally. As a result, changes in the relative coupon may also affect prepayments through the impact of interest rates on decisions to relocate and to default.

Homeowners may defer or decide against relocating when the interest rate on new mortgages is high compared to the rates on their existing mortgages. Conversely, when the mortgage rate drops, many homeowners are encouraged to pay off their old mortgages and to purchase a new home at the new, lower interest rate. Of course, when mortgage rates drop, prospective home buyers also find it easier to qualify for loans, and the demand for homes increases. This increase in demand makes it easier for homeowners to sell their current homes and relocate.

The interest rate may also be correlated with the decision to default. Interest rates typically fluctuate with national economic conditions, thus defaults due to unemployment and bankruptcy may be associated with movements in interest rates. In addition, home values are affected by changes in interest rates. Thus, defaults that result from borrowers walking away from their mortgage commitments may also be correlated with interest rates.

Figure 8 shows how prepayment rates in the Fixed Rate subset vary with the relative coupon.[46] Table 10 displays the data used in constructing this figure along with other statistics. The top panel of the figure shows the percent of the observations with prepayments as a function of the relative coupon. Surprisingly, the fraction of observations with prepayments is roughly bowl-shaped: the fraction lies below its

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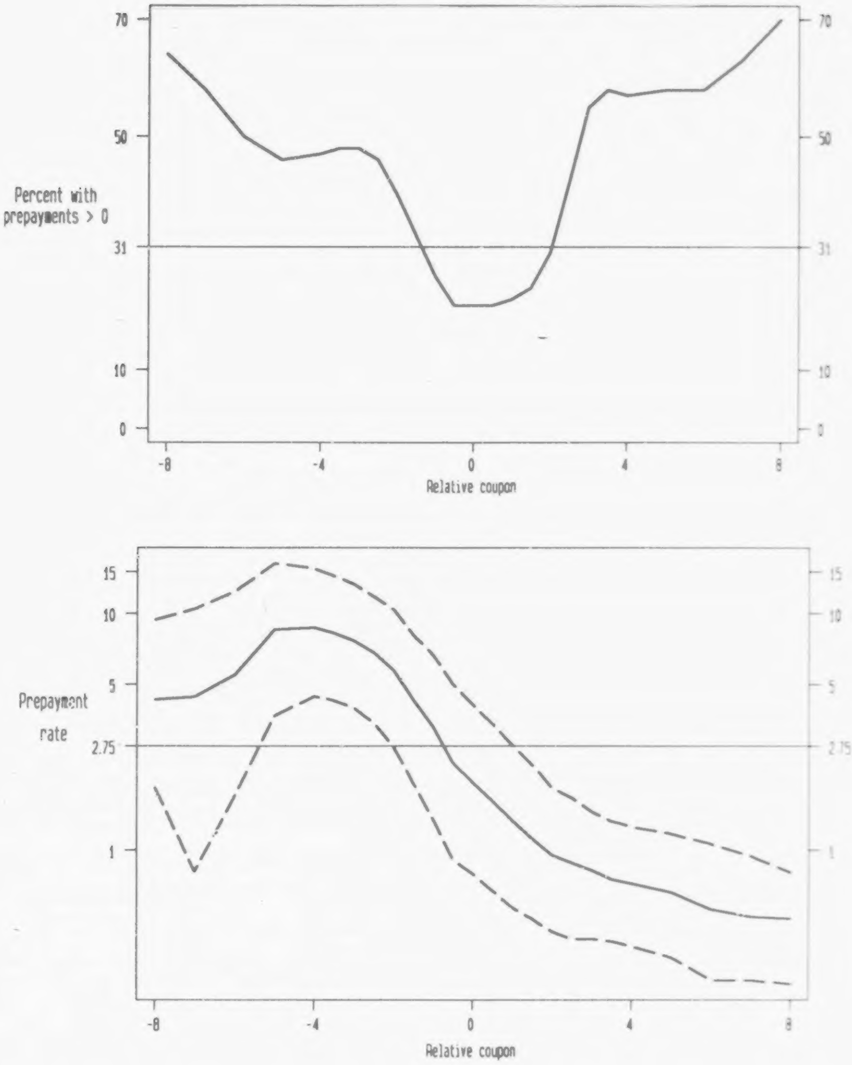
[46] Figure 8 only shows the prepayment behavior of pools with relative coupons between -8.0 and 8.0 percent. Relatively few observations had relative coupons outside this range and, as a result, prepayment estimates outside this range are unreliable.

Figure 8: Prepayment rates and relative coupon



mean in the range of relative coupons from -1.5 percent to 2.0 percent. Everywhere else the fraction lies above its mean.

The bottom panel of the figure displays the prepayment rate for the sub-sample with prepayments. Prepayment rates are measured on a ratio scale. As expected, the median prepayment rate is high when the relative coupon is low, that is, when the current mortgage rate is less than the contract rate on the existing mortgage and there is a strong incentive to refinance. The median prepayment rate is higher than 2.75 percent whenever the relative coupon is less than or equal to -1.0 percentage

Table 10: The Distribution of Monthly Prepayment Rates by Relative Coupon Rate

Relative coupon rate	Percent with $\rho > 0$	Number with $\rho = 1$	Statistics for sample with $\rho > 0$				Number of observations
			25th percentile	Median	75th percentile	Inter-quartile range	
-8.0	64	1	1.83	4.31	9.39	7.56	242
-7.0	58	5	.81	4.42	10.46	9.65	1,139
-6.0	50	10	1.69	5.49	12.38	10.69	3,102
-5.0	46	31	3.69	8.53	16.26	12.57	12,376
-4.0	47	50	4.45	8.71	15.41	10.96	32,415
-3.5	48	49	4.28	8.22	14.33	10.05	43,562
-3.0	48	46	3.99	7.65	13.25	9.26	62,406
-2.5	46	38	3.43	6.81	11.76	8.33	74,688
-2.0	40	26	2.73	5.71	10.35	7.62	75,990
-1.5	33	13	1.91	4.29	8.06	6.15	84,509
-1.0	26	5	1.35	3.30	6.65	5.30	96,813
-0.5	21	15	.91	2.34	5.00	4.09	111,225
0.0	21	4	.79	1.93	4.10	3.31	127,087
0.5	21	3	.67	1.61	3.39	2.72	139,646
1.0	22	1	.57	1.33	2.77	2.20	115,944
1.5	24	2	.51	1.12	2.29	1.78	86,232
2.0	30	1	.45	.95	1.83	1.38	48,603
2.5	42	2	.42	.88	1.66	1.24	22,520
3.0	55	1	.42	.82	1.45	1.03	15,299
3.5	58	1	.41	.75	1.32	.91	12,777
4.0	57	1	.39	.72	1.25	.86	15,146
5.0	58	0	.35	.66	1.17	.82	14,185
6.0	58	0	.28	.56	1.06	.78	6,279
7.0	63	0	.28	.52	.94	.66	2,138
8.0	70	0	.27	.51	.80	.53	610

All statistics in percent except the number of observations. Median and interquartile range calculated for subsample with $\rho > 0$.

points. There is a flattish peak in the median prepayment rate at a relative coupon of -4.0 percentage points. Whenever the relative coupon is above -1.0 percentage points, the median prepayment rate is less than 2.75 percent.

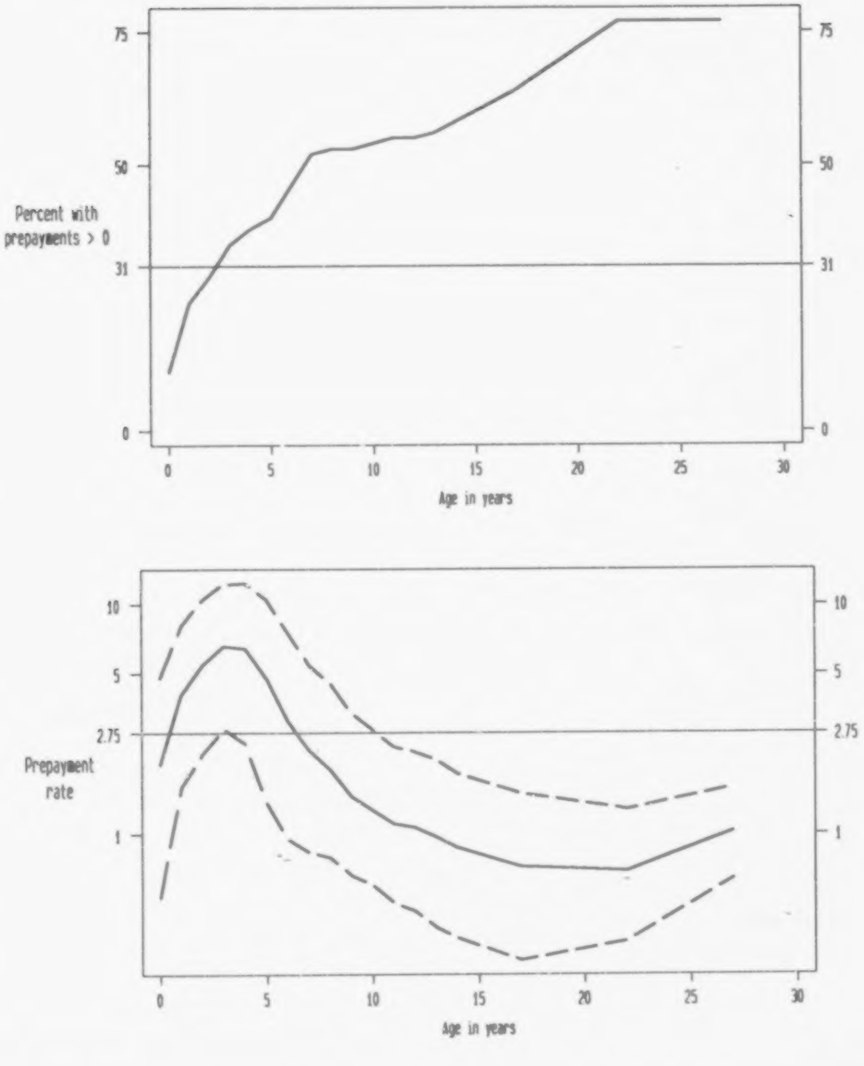
Age

Figure 9 displays the effects of mortgage age on prepayment rates. Table 11 displays the data used in constructing this figure along with other statistics.

In the first year of a mortgage pool's life prepayments are very low—only 11 percent of the observations have prepayments and the prepayment rates for those observations with prepayments are slightly below the median rate of 2.75 percent. Both the fraction of observations and the median prepayment rate conditional on some prepayment rise sharply in the next few years. In the third year, the median prepayment rate peaks at 6.55 percent, however the fraction of observations with prepayments continues to rise until the pool is 25 years old.

It is important to note that the calculations for the older pools are of questionable reliability. First, there are relatively few ob-

Figure 9: Prepayment rates and age



servations of older pools.[47] Second, the weighted average maturity of older pools is likely to be very different from the original weighted average maturity, the only measure of maturity available to us.[48] This

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[47] Only 15,425 of our 1,204,626 observations are on pools 20 years old or older. Only 2,076 of our observations are on pools 25 years old or older.

[48] There appear to be no formal restrictions on the dispersion of maturities within a FNMA pool. Thus, as individual mortgages prepay, the weighted average maturity of a pool can take large, discrete jumps. Discussions with FNMA indicate that the original weighted average maturity is often a very poor indicator of the current weighted average maturity for pools that are more than 15 years old.

Table 11: The Distribution of Monthly Prepayment Rates by Age

			Statistics for sample with $\rho > 0$				
Age in years	Percent with $\rho > 0$	Number with $\rho = 1$	25th percentile	Median	75th percentile	Inter-quartile range	Number of observations
< 1	11	7	.53	2.01	4.76	4.23	236,654
1	24	16	1.61	4.03	8.04	6.43	310,255
2	29	51	2.23	5.43	10.48	8.25	174,239
3	35	66	2.87	6.55	12.27	9.40	93,241
4	38	55	2.47	6.41	12.39	9.92	64,896
5	40	45	1.37	4.73	10.56	9.19	48,042
6	46	22	.95	3.10	7.56	6.61	37,137
7	52	11	.83	2.32	5.43	4.60	35,252
8	53	9	.79	1.91	4.52	3.73	34,110
9	53	2	.66	1.46	3.35	2.69	30,615
10	54	0	.60	1.27	2.84	2.24	25,171
11	55	0	.50	1.11	2.40	1.90	20,934
12	55	1	.46	1.07	2.28	1.82	16,626
13	56	7	.39	.97	2.10	1.71	14,149
14	58	3	.35	.87	1.83	1.48	12,137
15-19	64	8	.28	.72	1.50	1.22	35,743
20-24	77	2	.34	.69	1.28	.94	13,349
25-29	77	0	.64	1.03	1.60	.96	2,076

All statistics in percent except the number of observations.

latter point is crucial; simulations indicate that measurements of the prepayment rate are very sensitive to even modest errors in measuring a pool's maturity.

The pattern of the median prepayment rate can be explained by the pattern of household relocation. (The pattern of the fraction of pools with prepayments appears to depend mainly on the data problems discussed above.) Households can be roughly divided into two types: movers and stayers. Movers relocate frequently, thus they account for most of the relocations and for the peak in the median prepayment rate in the early years of a pool's life. Stayers do not relocate frequently. They account for the low median prepayment rate of pools that are more than five years old.[49]

Size of pools

Figure 10 displays the relationship between the pool size at origination and the distribution of prepayment rates.[50] Table 12 displays the data used in constructing this figure along with other statistics. Table 13 displays the same statistics when the pools are categorized by their current size.

Pools with larger numbers of mortgages should be more likely to have some prepayments in each period unless the prepayments are perfectly correlated across the individual mortgages. The figure and tables confirm this hypothesis. Pools with an original size of less than $2 million have fewer than the average number of observations with prepayments. Pools with an original size of $3 million or more have more than the average number of observations with prepayments. For the very largest pools—ones with $20 million or more in original size—more than 90 percent of the observations have prepayments.

One might also suspect that the variance of prepayments rates for those pools with prepayments would decline with the size of the pool, but, as Figure 10 indicates, this turns out not to be the case.[51] The interquartile range of prepayment rates is roughly constant across the

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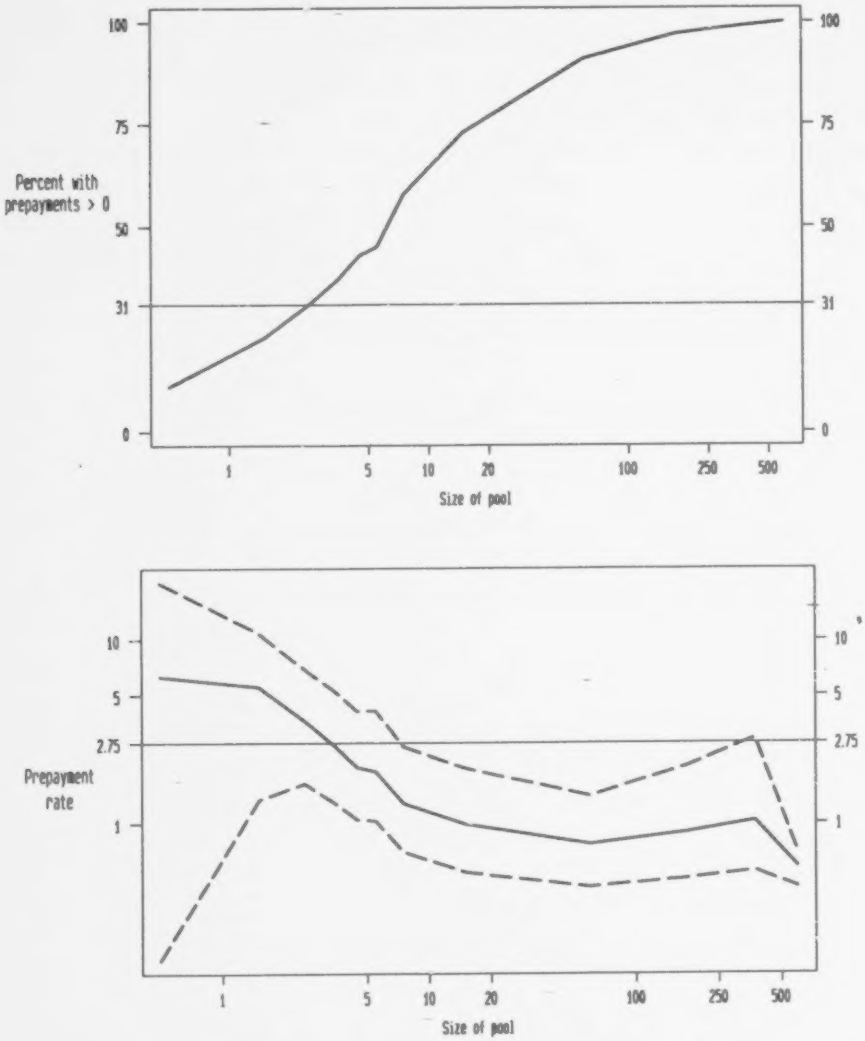
[49] The rate of refinancing is also low in the first year or two years of a mortgage pool. In part, the low rate of refinancing reflects the amount of time it takes before mortgage rates move far enough to outweigh the costs of originating a new loan.

[50] It turned out that measuring the pool size on a ratio scale improved the readability of this figure.

[51] The interquartile range does decrease with pool size in Table 12, however, this table reports the interquartile range before taking logs of the prepayment rates. After taking logs, the interquartile range is roughly constant, as it should be if the log transformation stabilizes the conditional variance of prepayments.

Figure 10: Prepayment rates and size of pool at origination



various pool sizes.[52] The median prepayment rate is highest for the smallest pools. The median rate declines until the pools are larger than $10 million dollars at origination, then it appears to flatten out.

Type of pool

Figure 11 displays the relationship between the type of

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[52] The interquartile range is higher for small pools. Recall that these smaller pools account for about half the observations in the sample.

Table 12: The Distribution of Monthly Prepayment Rates by Size of Pool at Origination

	1982-88						
			Statistics for sample with $\rho > 0$				
Size	Percent with $\rho > 0$	Number with $\rho = 1$	25th percentile	Median	75th percentile	Inter-quartile range	Number of observations
under $1 million	11	41	.18	6.32	20.45	20.27	22,809
$1-under $2 million	23	238	1.34	5.57	10.89	9.55	668,843
$2-under $3 million	31	16	1.65	3.63	6.93	5.28	193,463
$3-under $4 million	37	3	1.29	2.65	5.27	3.98	89,104
$4-under $5 million	43	1	1.05	2.02	4.09	3.05	57,689
$5-under $6 million	45	0	1.03	1.92	4.12	3.09	52,425
$6-under $10 million	58	1	.70	1.28	2.62	1.92	56,362
$10-under $20 million	73	1	.54	.99	1.99	1.45	39,385
$20-under $100 million	91	3	.45	.77	1.41	.96	19,450
$100-under $250 million	97	1	.50	.89	2.04	1.54	4,050
$250-under $500 million	99	0	.55	1.03	2.90	2.35	989
$500 million and over	100	0	.45	.58	.69	.24	57
All sizes	31	305	.87	2.75	7.09	6.22	1,204,626

	1986						
			Statistics for sample with $\rho > 0$				
Size	Percent with $\rho > 0$	Number with $\rho = 1$	25th percentile	Median	75th percentile	Inter-quartile range	Number of observations
under $1 million	11	4	.53	11.13	22.60	22.07	5,218
$1-under $2 million	34	45	3.57	7.34	12.63	9.06	142,108
$2-under $3 million	45	1	2.31	4.57	8.59	6.28	39.434
$3-under $4 million	50	0	1.74	3.55	7.18	5.44	17,937
$4-under $5 million	58	0	1.30	2.72	5.96	4.66	10,975
$5-under $6 million	60	0	1.29	2.74	6.27	4.98	10,073
$6-under $10 million	72	1	.83	1.71	4.44	3.61	10,816
$10-under $20 million	82	0	.70	1.42	3.67	2.97	7,623
$20-under $100 million	96	0	.59	1.04	2.07	1.48	3,624
$100-under $250 million	99	0	.78	1.42	4.07	3.29	737
$250-under $500 million	100	0	1.20	3.69	6.17	4.97	171
$500 million and over	100	0	.47	.58	.75	.28	7
All sizes	43	51	1.65	4.79	9.54	7.89	248,723

mortgages in the pool and the distribution of prepayment rates.[53] Table 14 displays the data used in constructing this figure along with other statistics.

In this sample, pools composed of FHA/VA mortgages and of conventional long-term mortgages have had prepayments more frequently than pools composed of intermediate-term mortgages and of assumable long-term mortgages. Because of their preponderance in the sample, conventional long and intermediate-term pools have had median prepayment rates that are typical of the sample as a whole. FHA/VA pools, on the other hand, have had quite low prepayment rates. In 1986,

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[53] To improve the readability of this figure, the interquartile bands are not shown in the bottom panel.

Table 13: The Distribution of Monthly Prepayments by Current Size of Pool

	1982-88					
		Statistics for sample with $\rho > 0$				
Size	Percent with $\rho > 0$	25th percentile	Median	75th percentile	Inter-quartile range	Number of observations
under $1 million	29	2.63	7.50	13.39	10.76	444,476
$1-under $2 million	22	1.47	3.53	6.24	4.77	396,526
$2-under $3 million	31	1.26	2.43	4.29	3.03	129,905
$3-under $4 million	39	1.00	1.83	3.32	2.32	64,203
$4-under $5 million	40	.90	1.53	2.60	1.70	52,807
$5-under $6 million	43	.73	1.27	2.21	1.48	26,670
$6-under $10 million	59	.59	1.02	1.76	1.17	47,143
$10-under $20 million	76	.46	.79	1.36	.90	24,847
$20-under $100 million	91	.42	.71	1.25	.83	13,167
$100-under $250 million	95	.41	.73	1.38	.97	2,147
$250-under $500 million	98	.43	.60	.79	.36	424
$500 million and over	100	.35	.44	.51	.16	6
All sizes	31	.87	2.75	7.09	6.22	1,204,626

	1986					
		Statistics for sample with $\rho > 0$				
Size	Percent with $\rho > 0$	25th percentile	Median	75th percentile	Inter-quartile range	Number of observations
under $1 million	44	5.33	9.31	15.13	9.80	90,302
$1-under $2 million	31	2.29	4.51	7.94	5.65	84,709
$2-under $3 million	29	1.66	3.22	6.14	4.48	27,547
$3-under $4 million	51	1.21	2.45	5.13	3.92	13,871
$4-under $5 million	35	1.06	2.00	4.03	2.97	9,348
$5-under $6 million	52	.85	1.60	3.65	2.80	5,824
$6-under $10 million	70	.73	1.37	2.97	2.24	9,055
$10-under $20 million	81	.56	1.00	1.90	1.34	4,856
$20-under $100 million	95	.58	.99	1.92	1.34	2,727
$100-under $250 million	99	.79	1.59	3.70	2.91	384
$250-under $500 million	100	.56	.76	2.55	1.99	49
$500 million and over	—	—	—	—	—	0
All sizes	43	1.65	4.79	9.54	7.89	248,723

the peak year for prepayments, the median prepayment rate for FNMA FHA/VA pools was only 1.08 percent. The assumable long-term pools had very low prepayment rates until 1986, when they shot above the other types of pools.

Location of pools

Table 15 lists prepayment statistics for the ten states with the largest share of mortgage pools.[54] The states are listed in decreasing order of their share of the mortgage pools. There appears to be little difference

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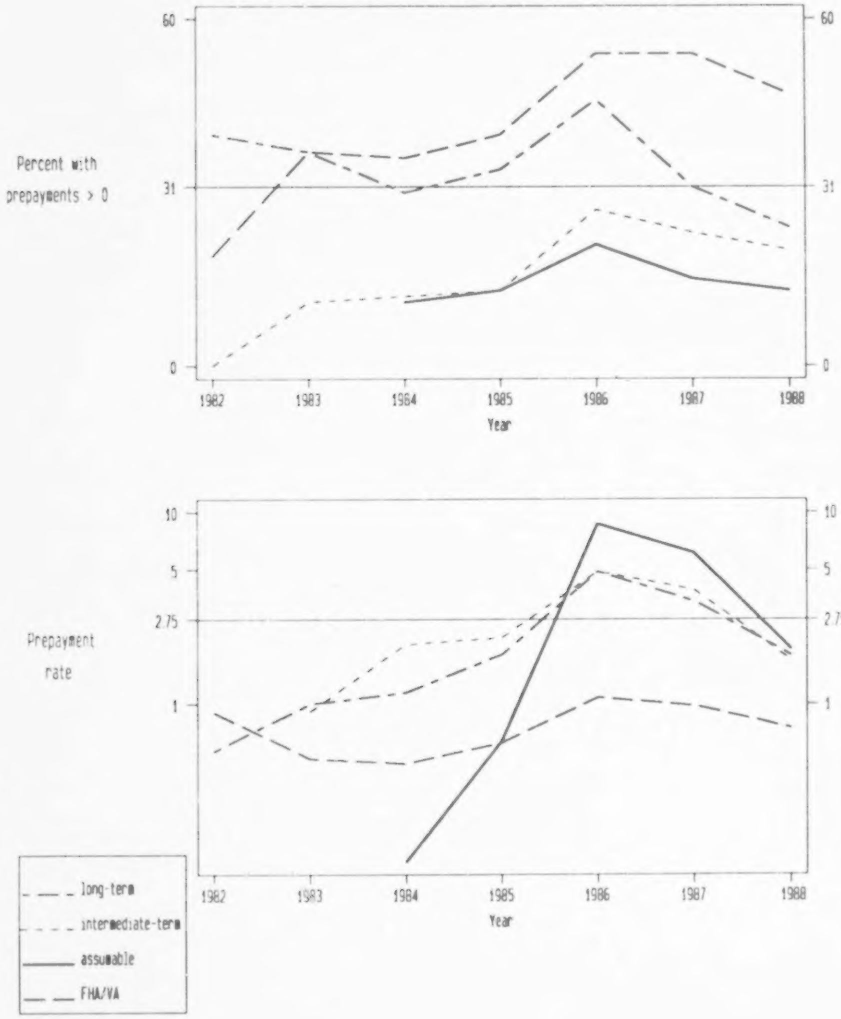
[54] Recall that the *Bond Buyer* tapes report the location of the originator/servicer. However this variable is a tolerably reliable guide to the location of the collateral. See Waldman, Peltz, and Lowen (1984, 1985).

Figure 11: Prepayment rates and type of pool



in the fraction of observations with prepayments across states. However, the median prepayment rate for observations with prepayments is noticeably higher in Massachusetts and somewhat higher in New Jersey and Missouri than in the other seven states. Florida has the lowest median prepayment rate.

D. Explaining the Distribution of Prepayments

The sections above examined the broad features of the relationships between observable variables and the distribution of

Table 14: The Distribution of Monthly Prepayment Rates by Type of Mortgage

	Long term mortgages				**Intermediate term mortgages**			
Year	Percent with $\rho > 0$	Median	Inter-quartile range	Number	Percent with $\rho > 0$	Median	Inter-quartile range	Number
1982	40	.57	.78	3,002	0	—	—	3
1983	37	1.00	1.73	26,616	11	.91	3.14	237
1984	30	1.15	2.07	58,272	12	2.04	3.96	1,369
1985	34	1.81	3.45	105,211	13	2.21	4.26	7,840
1986	46	4.89	8.08	200,020	27	4.86	6.87	40,412
1987	31	3.43	7.38	354,170	23	3.93	7.27	94,420
1988*	24	1.80	4.39	216,613	20	1.70	4.37	59,045
1982-88	33	2.82	6.34	963,904	24	3.45	6.59	203,326

	Assumable mortgages				**FHA/VA mortgages**			
Year	Percent with $\rho > 0$	Median	Inter-quartile range	Number	Percent with $\rho > 0$	Median	Inter-quartile range	Number
1982	—	—	—	0	19	.90	2.93	26
1983	—	—	—	0	37	.52	.76	1,669
1984	11	.15	3.31	38	36	.49	.70	2,704
1985	13	.64	2.70	405	40	.63	.91	4,136
1986	21	8.62	11.88	1,398	54	1.08	2.16	6,893
1987	15	6.13	15.00	2,700	54	.98	1.62	9,987
1988*	13	1.94	10.97	1,625	47	.75	1.05	5,815
1982-88	16	5.77	13.30	6,166	49	.85	1.39	31,230

All statistics in percent except the number of observations. Median and interquartile range calculated for subsample with $\rho > 0$.

* January-June only.

Table 15: The Distribution of Monthly Prepayment Rates by State

	1982-88						
			Statistics for sample with $\rho > 0$				
State	Percent with $\rho > 0$	Number with $\rho = 1$	25th percentile	Median	75th percentile	Inter-quartile range	Number of observations
California	33	53	.95	2.66	7.01	6.06	158,139
New York	30	9	.76	2.63	7.13	6.37	91,506
Massachusetts	30	95	2.20	5.74	11.94	9.74	103,678
Florida	37	5	.74	1.85	4.76	4.02	66,977
Texas	27	7	.77	2.61	6.33	5.56	82,656
Illinois	31	14	.77	2.08	5.27	4.50	71,278
Pennsylvania	32	8	.62	2.33	6.75	6.13	64,815
New Jersey	25	5	1.13	3.19	7.87	6.74	45,800
Ohio	34	4	.93	2.78	6.90	5.97	37,324
Missouri	29	4	1.41	3.89	8.26	6.85	27,283

	1986						
			Statistics for sample with $\rho > 0$				
State	Percent with $\rho > 0$	Number with $\rho = 1$	25th percentile	Median	75th percentile	Inter-quartile range	Number of observations
California	44	5	1.67	4.41	8.91	7.24	31,531
New York	40	0	1.27	4.54	9.03	7.76	19,569
Massachusetts	48	11	4.33	8.55	14.97	10.64	22,386
Florida	47	0	1.10	2.88	6.51	5.41	13,773
Texas	36	5	1.40	4.04	8.05	6.65	16,059
Illinois	43	1	1.28	3.30	7.48	6.20	12,438
Pennsylvania	41	1	1.45	4.61	9.42	7.97	13,126
New Jersey	36	1	1.91	5.37	10.15	8.24	8,588
Ohio	46	2	2.09	4.99	9.21	7.12	7,426
Missouri	41	1	2.54	5.66	10.44	7.90	5,872

prepayments. This section measures how far those relationships go in accounting for the variation of prepayments across observations. If observables can account for a substantial portion of the variability of prepayments, then modeling prepayments as a function of the observables is likely to be useful. If observables can account for only a negligible fraction of the variability of prepayments, then prepayments are essentially unpredictable and efforts to model them are likely to fail. Consistent with the treatment in previous sections, we examine the decision to prepay separately from the rate of prepayment when there is prepayment.

Explaining the decision to prepay

Table 16 displays some measures of the goodness of fit of a linear probability model of the decision to prepay. Formally, we categorize the observables in the same way they are categorized in the tables of the previous sections. Since all the potential explanatory variables are categorical, the fitted values are just the fraction of observations with prepayments in each cell. For example, our sample contains 2,906 observations of pools that are three years old and have relative coupons of one percent, that is, with the current mortgage rate one percent higher than the weighted average contract rate on the mortgages in the pool. Nineteen percent of those observations have prepayments, hence the fitted probability of a prepayment in that age and relative coupon cell is 19 percent. An observation is predicted to have a prepayment if the fitted probability is greater than one-half; otherwise, it is predicted not to have a prepayment.

For each set of explanatory variables, five statistics are recorded.[55] First is the number of parameters, which is just the number of different cells.[56] The second statistic is the log of the likelihood function. Let y_{ij} be defined to be 1 if the j-th observation in the i-th cell has a prepayment and to be 0 otherwise, and let $\hat{F}_i$ be the fitted probability of the i-th cell. Using these definitions, we can write the log likelihood as

$$\ell = \sum_{i,j} \left[y_{ij} \log \hat{F}_i + (1 - y_{ij}) \log(1 - \hat{F}_i) \right] .$$

Models with higher values of the log of the likelihood function are preferred.

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[55] These goodness of fit statistics are explained in more detail in Amemiya (1981).

[56] Note that, when more than one explanatory variable is in the set, the number of cells is less than the product of the numbers of cells along each margin. That is because some of the cells are empty, that is, they have no observations.

Table 16: Explaining the Decision to Prepay

Explanatory variables	Number of parameters	Log likelihood	AIC*	Percent† wrong	McFadden's‡ R^2
None	1	-750,365	750,366	31	—
Type of pool	4	-743,458	743,462	31	.01
State	51	-737,124	737,175	31	.02
Year	7	-738,464	738,471	31	.02
Size of pool	12	-688,206	688,218	27	.08
Age	18	-677,473	677,491	29	.10
Age and year	125	-658,617	658,742	28	.12
Relative coupon	27	-711,395	711,422	31	.05
Relative coupon and year	172	-695,419	695,591	29	.07
Relative coupon and age	432	-654,672	655,104	28	.13
Relative coupon, age, and type of pool	1,050	-651,442	652,492	28	.13
Relative coupon, age, and year	2,071	-640,219	642,290	27	.15
Relative coupon, age, and state	12,754	-630,722	643,476	26	.16
Relative coupon, age, and size of pool	3,538	-594,051	597,589	24	.21
Relative coupon, age, size of pool, year, state, and type of pool	119,147	-500,851	619,998	20	.33

Statistics calculated for the 1,204,626 observations in the Fixed Rate subset.

* Akaike's information criterion ≡ minus the log likelihood plus the number of parameters. Models with smaller values of the AIC are preferred.

† The number of wrongly classified observations as a fraction of all observations (in percent).

‡ McFadden's $R^2 \equiv 1 - (\ell / \ell_0)$ where ℓ is the log of the likelihood of the current fit and ℓ_0 is the log of the likelihood of the fit by a constant, that is, the fit reported in the row labeled 'None'.

The third statistic is the Akaike information criterion (AIC), a statistic which penalizes over-parameterized models. The criterion is defined as

$$AIC = -\ell + K$$

where K is the number of cells. Models with smaller values of the AIC are preferred. The fourth statistic is the percent of wrong predictions, that is,

$$\text{Percent wrong} = \frac{\sum_{i,j}(y_{ij} - \hat{y}_i)^2}{N}$$

where $\hat{y}_i$ is the predicted value of y_{ij} and N is the total number of observations. Clearly, smaller values of this statistic are preferred. The fifth statistic is McFadden's R^2, a normalization of the log of the likelihood that produces an R^2-like number. The definition of this statistic is

$$\text{McFadden's } R^2 = 1 - \frac{\ell}{\ell_0}$$

where ℓ_0 is the log of the likelihood when the observations are fit with only a constant term.[57]

The observable variables are moderately successful in accounting for the decision to prepay. The single most important variable for explaining the decision to prepay is the age of the pool; this variable reduces the percentage of wrong predictions from 31 percent—the percentage using only the sample fraction of observations with prepayments to fit the data—to 29 percent. McFadden's R^2 is .10 for this model. The second most important variable is the size of the pool at origination; this variable reduces the percentage of wrong predictions even further to 27 percent, but its McFadden's R^2 is only .08. Surprisingly, the relative coupon has very little ability to predict prepayments; it does not reduce the percentage of wrong predictions at all, and its McFadden's R^2 is only .05. The model with all the observables—a greatly over-parameterized model—has 20 percent wrong predictions and a McFadden's R^2 of .33.

Figure 12 displays the empirical distribution of the fraction of observations with prepayments by pool age and size of pool at origination, the two variables most important for explaining this fraction. The plane at the base of the pillars maps the various combinations of pool age and size at origination. The height of each pillar records the percentage of observations with prepayments for a given age and size combination. As Figure 12 shows, larger and older pools are more likely to have prepayments. The very tall pillars at the back of the figure show that very old pools are almost certain to have prepayments. As was noted above, some of these prepayments may be spurious because the true maturity of older pools is uncertain. The tall pillars at the right of the figure indicate that very large pools are also virtually certain to have prepayments. This is a more reliable indication, since the probability of at least one mortgage in a pool prepaying increases with the number of mortgages in the pool.

Explaining monthly prepayment rates

Table 17 displays goodness of fit statistics for simple models of the prepayment rate for the 379,240 observations with prepayments. Because this is an exploratory analysis of prepayment rates and because of the peculiarities of the prepayment distribution, we decided to fit prepayment rates by the cell median prepayment rates using the same definitions of the cells as we used in Table 16. The statistics in Table 17

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[57] This is the fit obtained when the fitted probability of prepayment for all observations is 31 percent (the fraction of all observations with prepayments). This fit is reported in the row labeled 'None'.

Figure 12: The fraction of observations with prepayments by age and size at origination

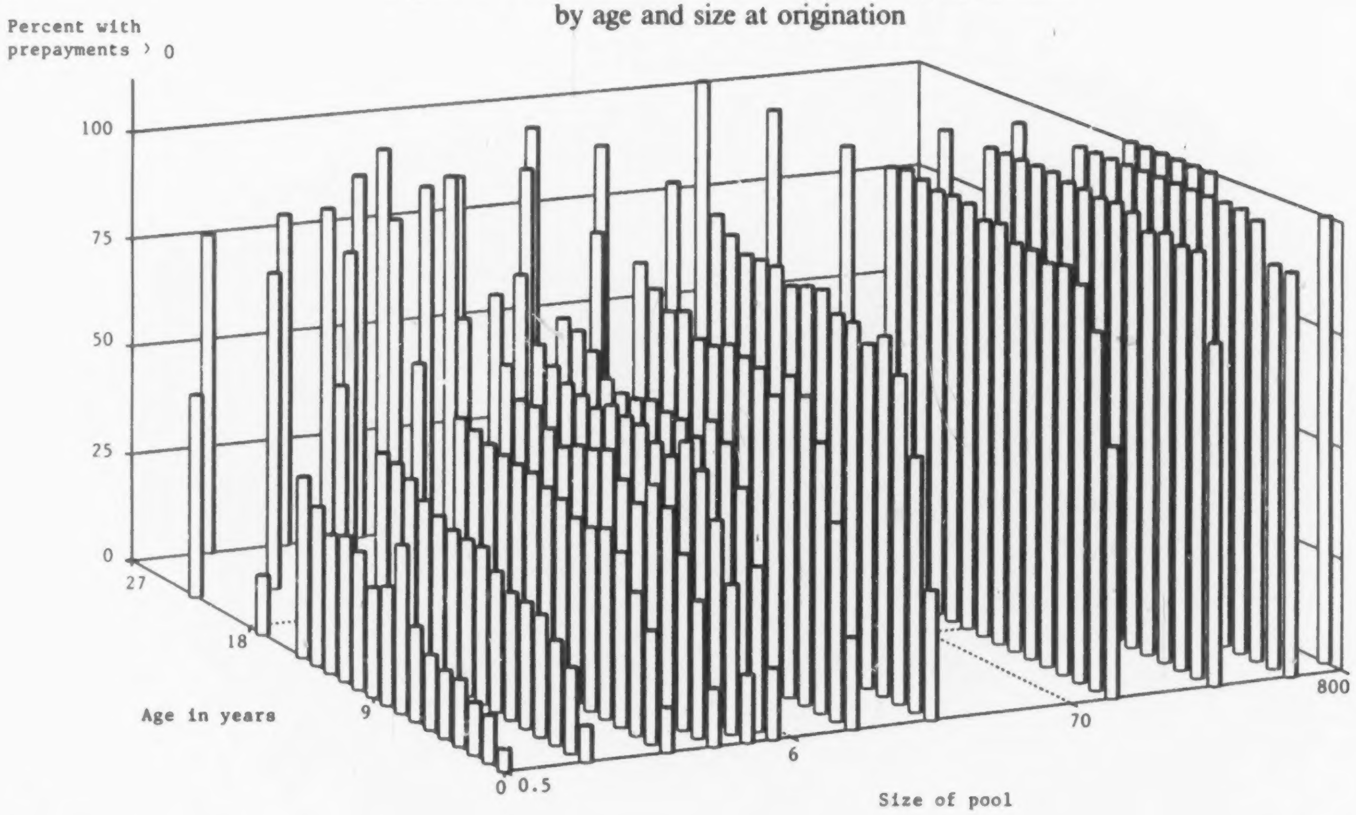

Table 17: Explaining Monthly Prepayment Rates

Explanatory variables	Number of parameters	Residual absolute variation	P*	$\frac{100 - P^\dagger}{DF}$
	Fitting the median prepayment rate			
Fit by cell medians				
None	1	16,627	—	—
Type of pool	4	16,476	1	2.61
State	51	16,178	3	2.56
Year	7	15,961	4	2.53
Size of pool	12	15,161	9	2.40
Age	18	14,923	10	2.37
Age and year	125	13,865	17	2.19
Relative coupon	27	13,603	18	2.16
Relative coupon and year	171	13,425	19	2.14
Relative coupon and age	423	13,212	21	2.09
Relative coupon, age, and type of pool	980	13,146	21	2.09
Relative coupon, age, and year	1,938	12,985	22	2.07
Relative coupon, age, and state	11,596	12,588	24	2.07
Relative coupon, age, and size of pool	3,387	12,259	26	1.97
Relative coupon, age, size of pool, year, state, and type of pool	88,300	9,775	41	2.03
Fit by median polish‡				
additive fit				
to the data	43	13,734.0	17	2.19
to the cell medians	43	4.8	47	.0126
extended fit				
to the data	44	13,777.0	17	2.19
to the cell medians	44	3.7	59	.0097

Statistics calculated for the 379,240 observations with positive prepayments.

* $P \equiv 100 \left(1 - \frac{\sum\sum |\tau_{ij}|}{\sum\sum |\rho_{ij} - m|} \right)$ where the τ_{ij} are the residuals in the i-th category, the ρ_{ij} are the prepayment rates in the i-th category, and m is the median prepayment rate. P is a measure of the fraction of residual absolute variation explained by the fit.

† $\times 10^4$. $(100 - P)/DF$ is the percent of total absolute variation left unexplained per degree of freedom. It provides one criterion for choosing between different fits.

‡ The results of fitting by the method of median polish the cell medians by relative coupon and age.

indicate how well the cell medians fit the rate of prepayment for those observations known to have prepayments.

For each set of explanatory variables, four statistics are recorded.[58] First is the number of parameters, which, again, is just the number of different cells.[59] The second statistic is the residual absolute

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[58] These goodness of fit statistics are explained in more detail in Emerson and Wong (1985).

[59] Because Table 17 analyzes only the 31 percent of the sample with prepayments, the number of parameters can be lower (the number of empty cells can be higher) than reported in Table 16.

Table 17: Explaining Monthly Prepayment Rates (cont.)

Fitting the median log of the prepayment rate				
Explanatory variables	Number of parameters	Residual absolute variations	P*	$\frac{100 - P^{\dagger}}{DF}$
Fit by cell medians				
None	1	451,324	—	—
Type of pool	4	443,802	2	2.58
State	51	435,420	4	2.53
Year	7	425,445	6	2.48
Size of pool	12	395,475	12	2.32
Age	18	385,782	15	2.24
Age and year	125	356,094	21	2.08
Relative coupon	27	348,032	23	2.03
Relative coupon and year	171	343,849	24	2.00
Relative coupon and age	423	337,762	25	1.98
Relative coupon, age, and type of pool	980	335,646	26	1.96
Relative coupon, age, and year	1,938	331,358	27	1.93
Relative coupon, age, and state	11,596	317,763	30	1.90
Relative coupon, age, and size of pool	3,387	307,334	32	1.81
Relative coupon, age, size of pool, year, state, and type of pool	88,300	230,544	49	1.75
Fit by median polish‡				
additive fit				
to the data	43	340,620.0	25	1.98
to the cell medians	43	99.6	71	.2627
extended fit				
to the data	44	340,195.0	25	1.98
to the cell medians	44	86.9	74	.2299

Statistics calculated for the 379,240 observations with positive prepayments.

* $P \equiv 100\left(1 - \dfrac{\sum\sum|\tau_{ij}|}{\sum\sum|\rho_{ij} - m|}\right)$ where the τ_{ij} are the residuals in the i-th category, the ρ_{ij} are the prepayment rates in the i-th category, and m is the median prepayment rate. P is a measure of the fraction of residual absolute variation explained by the fit.

† $\times 10^4$. $(100 - P)/DF$ is the percent of total absolute variation left unexplained per degree of freedom. It provides one criterion for choosing between different fits.

‡ The results of fitting the cell medians by relative coupon and age by the method of median polish.

variation, a robust measure of the spread of a distribution. Let ρ_{ij} be the prepayment rate of the j-th observation in the i-th cell, and let m_i be the median prepayment rate in the i-th cell, that is, the median (over j) of the ρ_{ij}. The j-th residual in the i-th cell is

$$\tau_{ij} = \rho_{ij} - m_i$$

and the residual absolute variation is $\sum_{i,j}|\tau_{ij}|$.

The third statistic, P, is a goodness of fit measure that is very roughly analogous to an R^2 statistic. It is defined as

$$P = 100 \left(1 - \frac{\sum_{i,j} |r_{ij}|}{\sum_{i,j} |\rho_{ij} - m|}\right)$$

where m is the median prepayment rate of all the observations with prepayments. The denominator of the term in parentheses is the residual absolute variation from a model that uses only the grand median to explain prepayment rates.[60] Thus, P can be interpreted as the percentage of the total absolute variation explained by the current model.[61] It is in this sense that P is like R^2.

The fourth statistic is a measure related to P that makes a correction for degrees of freedom. This statistic is the percentage of the total absolute variation of the prepayment rate left unexplained by the model per residual degree of freedom. Models with small values of this statistic are preferred. The first page of Table 17 reports statistics for fitting the median prepayment rate. The second page of Table 17 reports the same statistics for fitting the log of the median prepayment rate.

Observable variables are more successful in accounting for prepayment rates than they are in accounting for the decision to prepay. As expected, the relative coupon is the single most important variable for explaining prepayment rates; it accounts for 18 percent of the residual absolute variation of the median prepayment rate (23 percent of the log of the median prepayment rate). The next most important variable is the age of the pool (accounting for 10 percent of the residual absolute variation of the prepayment rate and 15 percent of the log) followed by the size of the pool at origination (9 and 12 percent, respectively). The combined explanatory power for the relative coupon and the age of the pool is 21 percent (25 percent for the log transformation). Adding additional factors to the fit by relative coupon and age produces relatively small improvements. However, using all of the explanatory factors can account for 41 percent of the total absolute variation (49 percent for the log transformation).

A tractable model of prepayments can not contain as many parameters as are used when fitting the data by cell medians. To explore the ability of a manageable model to account for the distribution of prepayments, we fit the data using *median polish*, a robust exploratory fitting technique that puts few constraints on the shape of the fit.[62] Median polish is typically used to analyze two-way tables or two-way layouts, although it can be used to analyze higher-order models.[63]

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[60] This residual absolute variation is reported in the row labeled 'None' in the table.

[61] If the model fits perfectly, that is, if all the residuals are zero, the P is 100. For arbitrary methods of fitting the data, P has no lower bound; P can be negative, for the same reasons that R^2 can be negative in instrumental variables or two-stage least squares estimation.

We used median polish to fit the cell median prepayment rates by relative coupon and age, the two variables with the greatest ability to account for the distribution of prepayment rates. Let m_{ij} be the median prepayment rate for the cell defined by the i-th relative coupon category and the j-th age category.[64] We fit the m_{ij} as

$$m_{ij} = m + \alpha_i + \beta_j + \epsilon_{ij} ,$$

that is, we decompose the m_{ij} into the sum of a common effect, m, an effect for the i-th relative coupon category, α_i, an effect for the j-th age category, β_j, and a residual, ϵ_{ij}. Note that, if we fit the data by means, this model would just be a main effects ANOVA model for a two-way layout.[65] Median polish estimates this decomposition by iteratively fitting one margin or another of the table. In other words, median polish proceeds by first fitting the m_{ij} by the row medians alone. It takes the residuals from this step and fits them by the column medians alone. This sequence is repeated until a reasonable fit is obtained.[66] The final estimate typically is close to a least absolute deviations estimate of the same model.

The lower section of each page of Table 17 reports the fit of a median polish of the table of relative coupon and age cell medians. The first row of the section reports how well the model fits the sample of 379,240 observations with prepayments. The model explains 17 percent of the residual absolute variation (25 percent for the log transformation)—roughly the same level of explanatory power of the cell medians by relative coupon alone. The second row of the section reports how well the model fits the table of relative coupon and age cell medians. The model explains 47 percent of the residual absolute variation (71 percent for the log transformation).

Diagnostic plots of the residuals from median polish gave some evidence that a simple additive fit might not be adequate to capture the effects of relative coupon and age on the prepayment rate. To explore this possibility, we used median polish to fit the extended model

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[62] Good discussions of median polish can be found in Emerson and Hoaglin (1983) and Emerson and Wong (1985).

[63] See Cook (1985) for a discussion of extending median polish to higher-order models.

[64] Note the change in notation here. Above, we used x_{ij} to denote the j-th observation in the i-th cell of a variable x, that is, the index i represented the compression into a single index of the indices for the various categories and masked the order of the model.

[65] Instead of fitting the m_{ij}, we could fit the ρ_{ijk}, that is, we could fit the individual observations of prepayment rates. However, it would be inconvenient to apply median polish to a data set as large as ours. In addition, median polish is an exploratory statistical technique, hence our purposes should be equally well-served by fitting the two-way table of cell medians.

[66] See Emerson and Hoaglin (1983) for more details on the computation of median polish.

$$m_{ij} = m + \alpha_i + \beta_j + \gamma\alpha_i\beta_j + \epsilon_{ij}\,.$$

This extension is the robust analog to Tukey's 'one degree of freedom for non-additivity' in ANOVA models.[67]

The next two rows of the section report the fit of the median polish estimate of this extended fit. There is essentially no difference in the ability of the two forms of the model to fit the individual observations. However, the extended fit does somewhat outperform the additive fit in capturing the shape of the cell medians.

Figure 13 displays the median prepayment rate for those observations with prepayments by relative coupon and pool age, the two variables most important for explaining the median prepayment rate. The plane at the base of the pillars maps the various combinations of relative coupon and pool age. In this chart, age increases from left to right on the front axis, and relative coupon *decreases* from front to back on the right axis. The height of each pillar records the median prepayment rate for a given relative coupon and age combination. Median prepayment rates are measured on a ratio scale.

As Figure 13 shows, the median prepayment rate, for those pools with prepayments, increases sharply as mortgage rates fall (as the relative coupon falls). The rate is also slightly higher for younger pools. The figure strongly suggests that the effects of relative coupon and age are not additive: the pillars could be roughly fit with a plane that tilted up in the corner displaying young pools with negative relative coupons and down in the corner displaying old pools with positive relative coupons.

Figure 14 displays the fit from an additive median polish fit of the log of the median prepayment rate. This figure depicts the fitted values from the median polish model reported in the bottom panel of the second page of Table 17. In this figure, the fitted values are connected to form a surface rather than plotted with individual pillars. This representation emphasizes the assumption that the expected median prepayment rate should change smoothly as a function of the relative coupon and age. As Figure 14 shows, the median polish model captures the basic shape of the data rather well. The most prominent feature, as in the 3-dimensional scatter diagram of the cell medians, is the peak in prepayment rates at low relative coupons. The steady decline in prepayment rates after the second

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[67] See Tukey (1949) for the original proposal in the ANOVA context and Emerson and Hoaglin (19830 for a discussion of the median polish version of the model.

Figure 13: The median prepayment rate by relative coupon and age for those observations with prepayments

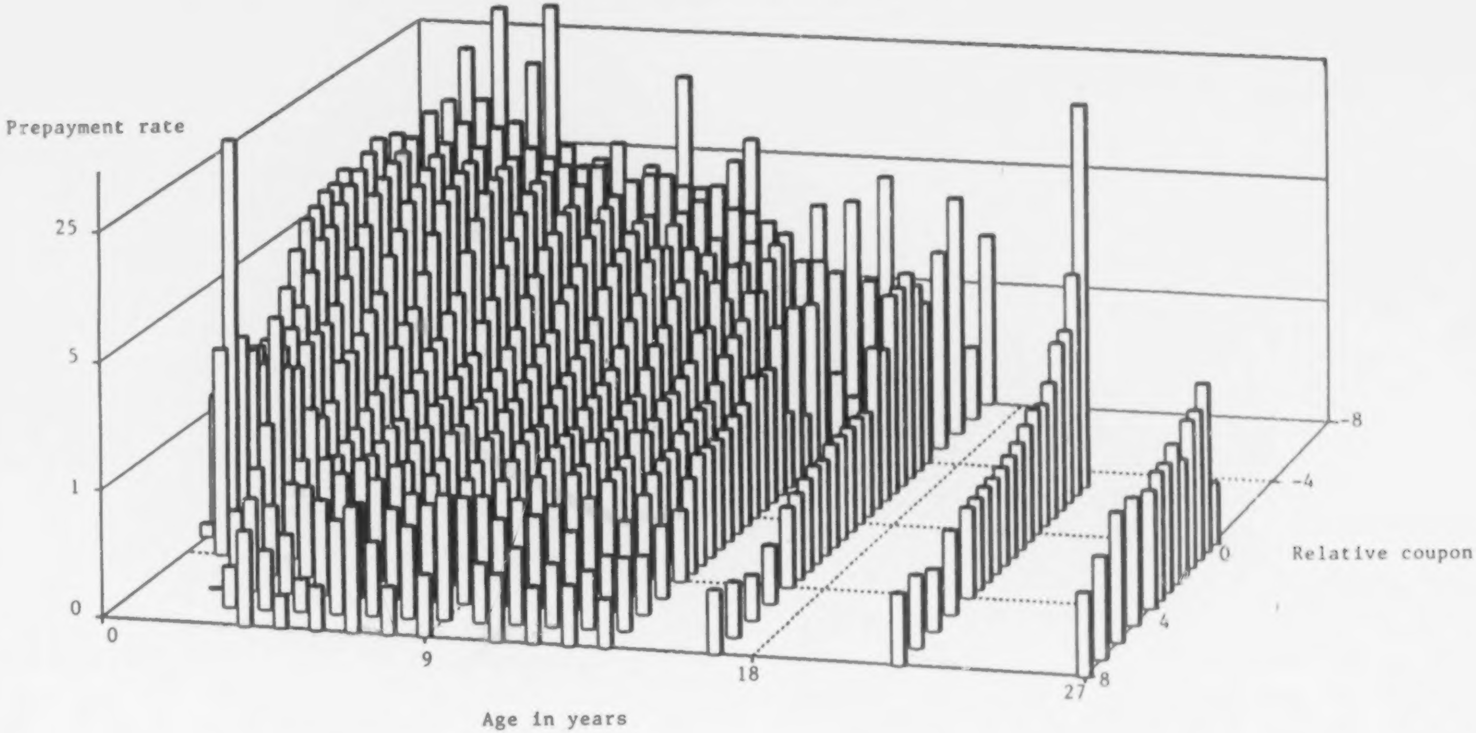
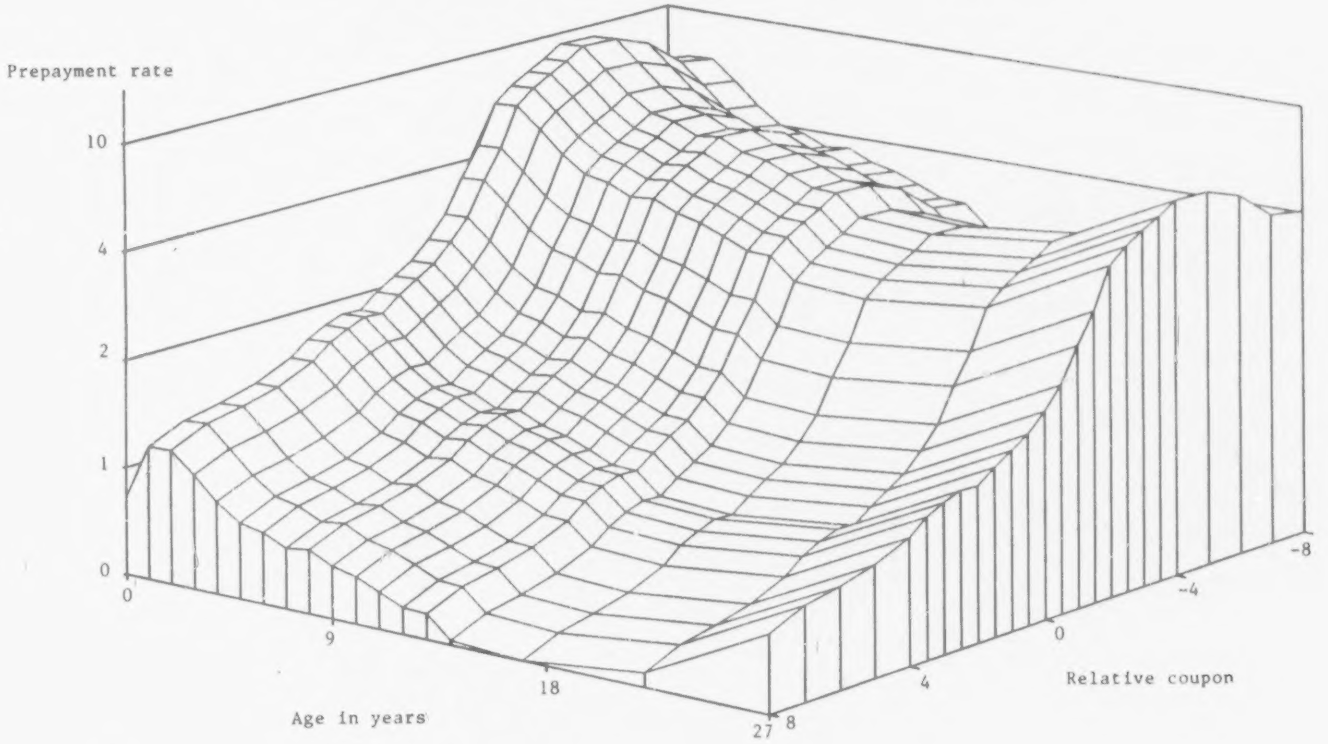


Figure 14: Fitted values from a median polish of the median prepayment rate by relative coupon and age for those observations with prepayments



year of a mortgage pool's life is also apparent as is the uptick, real or artifactual, in the last few years of a pool's life. Notice that the fitted values ignore, by construction, the few cells with extremely high prepayment rates. (Compare Figure 14 to Figure 13.)

E. Fast and Slow Pay Pools

Much of the market commentary on mortgage-backed securities focuses on identifying so-called *fast pay* and *slow pay* pools, that is pools that consistently pay out faster or slower, respectively, than apparently comparable pools. It is often asserted that pools are priced 'generically', that is, that all, say, FNMA 9s have roughly the same price at any point in time. In this situation, an investor who can identify fast and slow pay pools can profit from the market's inefficiency. This hypothetical investor will fill his or her portfolio with fast pay discount and slow pay premium securities.

Table 18 reports the results of a somewhat simplistic approach to identifying fast and slow pay pools. In this table, pools are grouped by their pass-through rate. This stratification helps to control for the effect of the relative coupon on prepayments.[68] We measure each pool's underlying tendency to prepay by the *life-to-date CPR*, denoted by $\bar{\rho}$. This statistic is the hypothetical prepayment rate that, if it had obtained each period, would have brought the pool to its observed current balance. $\bar{\rho}$ abstracts from the time pattern of prepayments and focuses instead on the cumulative intensity of prepayments.[69] We use each pool's value of $\bar{\rho}$ in June 1988, the last month in our sample. Only pools that were in the sample for more than two years are included.

We use a statistic designed to identify potential outliers to select fast and slow pay pools. First, within each pass-through rate group, we calculate the empirical distribution of $log(1 + \bar{\rho})$.[70] Let p_{25} and p_{75} be the 25th and 75th percentiles, respectively, of this empirical distribution. Any pool with a value of $\bar{\rho}$ greater than $p_{75} + 1.5(p_{75} - p_{25})$ is designated a fast pay pool. Any pool with a value of $\bar{\rho}$ less than $p_{25} - 1.5(p_{75} - p_{25})$

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[68] In the absence of a reliable statistical model of prepayments, it is unclear how to identify fast and slow pay pools. Grouping pools by pass-through rate is traditional and sensible, since it controls for the relative coupon if the pools are observed over the same time period. The statistical measure described below should flag any pools that have consistently deviant prepayment behavior.

[69] See Appendix A for a derivation of $\bar{\rho}$.

[70] We use the log transformation to mitigate the concentration of the distribution of prepayment rates around zero and to stabilize the variance of the prepayment rate.

Table 18: Fast and Slow Pay Pools

		Medians		
Type of pools	Number	$\bar{\rho}$	Age†	Size at origination‡
FNMA 7s				
Average	185	.1	18.3	2.5
Fast pay	11	.4	12.8	4.2
FNMA 9s				
Slow pay	4	0.0	2.3	1.0
Average	661	.3	3.0	2.0
Fast pay	47	1.2	2.3	1.0
FNMA 11s				
Average	2,037	1.9	3.0	1.5
Fast pay	58	5.0	2.9	1.0
FNMA 13s				
Average	1,166	2.6	5.3	1.1
Fast pay	18	7.2	3.7	1.0

Statistics calculated as of June 1988 for pools with the listed pass-through rates that were more than two years old and that had been in the sample for more than two years.
† in years.
‡ in millions of dollars.

or with $\bar{\rho} = 0$ is designated a slow pay pool.[71] Note that this definition may not identify any pools as either fast or slow pay. This is a desirable feature; a group of pools may be extremely homogeneous. In this case, there is no reason to set aside some of the pools as fast or slow pay.

As shown in Table 18, there are only four slow pay pools in these data and these are all FNMA 9s.[72] Each of the groups has some fast pay pools. Six percent of the FNMA 7s are fast pay pools as are 7 percent of the FNMA 9s, 3 percent of the FNMA 11s, and 2 percent of the FNMA 13s. The median life-to-date CPR is roughly four times higher than average for the fast pay pools among the FNMA 7s and 9s and roughly two-and-a-half times higher than average for the fast pay pools among the FNMA 11s and 13s.

Table 18 also reports, for each group, the median values of the age of a pool and its size at origination, two observables that are related to prepayments. For the FNMA 7s and 13s, the fast pay pools tend to be somewhat younger than the other pools. However, for the FNMA 9s and 11s, there is no substantial difference in pool age. The fast FNMA 7s are from larger than average pools. For the other groups, the fast pay pools are from somewhat smaller than average pools.

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[71] Excluding the pools with $\bar{\rho} = 0$, these fast and slow pay pools are just the *outside values* of the empirical distribution. See Chambers et. al. (1983), Hoaglin (1983), Emerson and Strenio (1983), and Hoaglin and Iglewicz (1987) for discussions of outside values.

[72] All four of these pools have $\bar{\rho} = 0$. They do not qualify as outside values.

In any given period, some pools will pay out faster or slower than average. Identifying fast and slow pay pools is useful only if today's fast and slow pay pools are also likely to be tomorrow's fast and slow pay pools. Table 19 attempts to measure how well past prepayment rates predict future prepayment rates. In Table 19, the sample is split into an early and a late period and the life-to-date CPR for each period is calculated. For example, for the statistics reported in the first column, the early period includes all the observations from the issuance of the security through December 1983, and the late period includes all the observations from January 1984 through June 1988. Pools are included only if they were more than two years old as of the sample break point (December 1983 in this case) and if they had been observed for more than a year by the date of the break point. Table 19 reports Kendall's τ as the measure of predictability or association between $\bar{\rho}$ in the early period and $\bar{\rho}$ in the late period. Kendall's τ is a nonparametric measure of correlation.[73]

The first row of Table 19 reports Kendall's τ for all pools and breaking the sample after December 1983, December 1984, December 1985, and December 1986.[74] The table shows that past values of $\bar{\rho}$ are useful but not perfect predictors of later values; the correlation coefficients lie between .32 and .46. The second row of the table reports the marginal significance, or p-value, of Kendall's τ. When the data is pooled across pass-through rates, τ is highly significant. The third row reports the number of observations available to calculate τ for each break point.

The later rows in Table 19 report the same triad of statistics—τ, p-value, and number of observations—for selected pass-through rates. For those cases with sufficient observations to produce a statistically signficant estimate of τ, the results are roughly consistent with the estimates for all pools. τ is greater than zero, both statistically and substantively, but it is less than .5.

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[73] The distribution theory of Pearson's τ, the traditional correlation coefficient is well established only for variables that are roughly normally distributed; $\bar{\rho}$ clearly does not fall into this category. Spearman's τ_3, also called the rank-order correlation coefficient, is a nonparametric statistic that overcomes this difficulty, but τ_3 is less useful when there are frequent ties in ranks, that is, when particular values occur frequently in the data; $\bar{\rho}$ is frequently equal to 0. Kendall's τ is, in some sense, an even more nonparametric statistic that τ_3; τ uses only the relative ordering of ranks rather than the numerical difference of ranks. Kendall's τ is appropriate both for non-normally distributed data and for ordered categorical data. Since $\bar{\rho}$ can be regarded as a mixture of a non-normal continuous variable and a discrete variable, Kendall's τ is the most appropriate correlation coefficient to use. See Press et. al. (1986, Chapter 13) for a discussion of the various correlation coefficients.

[74] There is no need to stratify the observations by pass-through rate when calculating Kendall's τ. We are correlating the early period $\bar{\rho}$ and the late period $\bar{\rho}$ for the same period.

Table 19:
Predicting Future Prepayments on the Basis of Past Prepayments

	Sample split after:			
Type of pools	1983	1984	1985	1986
All pools				
Kendall's τ	.43	.32	.42	.46
$P(z > \|\tau\|)$*	.00	.00	.00	.00
Number of observations	705	3,031	5,977	10,100
FNMA 7s				
Kendall's τ	.36	.13	.17	.11
$P(z > \|\tau\|)$*	.10	.14	.01	.04
Number of observations	10	65	108	149
FNMA 9s				
Kendall's τ	.01	.08	.13	.25
$P(z > \|\tau\|)$*	.97	.28	.02	.00
Number of observations	28	94	156	236
FNMA 11s				
Kendall's τ	.49	.17	.26	.23
$P(z > \|\tau\|)$*	.01	.39	.00	.00
Number of observations	15	79	163	414
FNMA 13s				
Kendall's τ	-.07	.07	.09	.11
$P(z > \|\tau\|)$*	.73	.10	.00	.00
Number of observations	15	237	643	1,109

Statistics calculated as of June 1988 for pools with the listed pass-through rates that were more than two years old and that had been in the sample for more than one year.

* Probability of observing a value of τ greater in absolute value than the value actually observed under the null hypothesis that the true value of τ is 0.

V. Conclusion

This monograph is the prelude to a formal model of prepayments. The results reported in this monograph suggest which variables are likely to be most important in modeling prepayments and give some guidance as to the most appropriate form of the statistical model for prepayments. The next step is to construct and estimate such a model and to evaluate the predictability of prepayments. The final step is to use the prepayment model in an MBS pricing model. In addition, we also plan to extend the analysis to GNMA and FHLMC MBSs.

A. Findings

Many facets of the FNMA MBSs were examined, and it is useful at this point to summarize more compactly some of the more important findings.

Types of mortgages: The majority of the FNMA pools contain conventional, long-term mortgages. Fixed rate, level payment mortgages account for 81 percent of all the FNMA pools.

Weighted average coupons: As a result of the age distribution of the FNMA MBSs, most of the pools have a weighted average coupon of between 8 and 10 percent.

Age of mortgages: Because FNMA's MBS program is relatively new, most of its MBSs have been issued recently and most of these contain new, and hence young mortgages. As of June 1988, 61 percent of the FNMA MBSs contained mortgages that were less than five years old.

Size of pools: Over half the pools are small, one to two million dollars at origination. As a practical matter, this small size limits the diversification benefits of pooling; a pool may contain fewer than 10 mortgages.

Market share of servicers: A handful of servicers account for a significant share of all FNMA MBSs. From July 1987 through June 1988, the 10 largest originator/servicers accounted for 21 percent of the total market, 31 percent when multiple pools are excluded.

Frequency and size of prepayments: Prepayments occur in 31 percent of the observations. Most prepayments are very small suggesting that most prepayments represent the partial, rather than complete, prepayment of one or two mortgages in a pool. Informal discussions with mortgage servicers appear to support this impression.

Idiosyncratic prepayment behavior: Pools prepay in idiosyncratic ways. Some pools do not prepay at all even in periods of generally high prepayments. Some pools prepay smoothly over time. Some pools prepay in short bursts with long periods of no prepayment between the bursts. As a result, investors holding small numbers of pools may find statistics on average prepayment rates to be of little use in predicting their cash flows.

Determination of prepayments: The age and size of a pool appear to be important in predicting whether a pool will have prepayments in a given month. The relative coupon and age of a pool appear to be important in accounting for the prepayment rate of those pools with prepayments. Somewhat surprisingly, the relative coupon does not appear to help predict the likelihood of prepayment.

The behavior of pools with older mortgages is clouded by measurement error. FNMA pools are not homogeneous with respect to the ages of the mortgages they contain. These age differences can have a substantial impact on the measured prepayment rate as the pool ages.

Fast and slow pay pools: Simple statistical methods can identify pools that have paid out faster and slower than comparable pools over the sample period. Most of these pools are fast pay pools; the techniques we used found only a few slow pay pools. A pool's past prepayment speed appears to provide useful but imperfect information about its future prepayment behavior.

B. Directions for Future Research

To model prepayments at the pool level, it is necessary to account for the majority of observations with no prepayments. A censored regression model of the tobit type seems most promising. It also would be desirable to estimate a doubly censored regression model to account for the probability of complete prepayment, but the FNMA MBSs have so few pools (305) that pay off that it may not be possible to estimate this more complicated model.

The results of this monograph suggest that the relative coupon, age, and size at origination of the pool are likely to be the most important explanatory variables in any model of prepayments. The idiosyncratic prepayment behavior of FNMA MBSs suggests that some form of persistence or state-dependence may play a role in the model. The rapid decline in prepayment rates after 1986 indicates that 'burnout', that is, increasing insensitivity over time to interest rate changes, may be a feature of this state-dependence. Preliminary attempts to fit prepayment rates to observable variables suggest that a parametric model is likely to account for 10 to 25 percent of the variation in prepayment rates. This is a level of explanatory power worth achieving, but one that leaves a substantial amount of prepayment behavior unexplained.

Appendix A

Calculating Prepayment Rates

Notation

There are three sets of payments and balances to keep straight. First, there are the *originally scheduled* payments and balances, that is, the payments and balances defined by the original amortization schedule, the ones that would occur if there never were any prepayments. Second, there are the *actual* payments and balances, the ones that actually occur over the life of the mortgage. Third, there are the *conditionally scheduled* payments and balances. These are the payments and balances that would occur, given the actual payments and balances to date, if there are no further prepayments. Originally scheduled quantities have an asterisk superscript (*), conditionally scheduled quantities have a tilde above them (˜), and actual quantities have no special mark. Our notation is summarized below.

m = the originally scheduled number of payment months.

τ = the fixed monthly interest rate.

B_t^* = the originally scheduled balance on principal at the end of month t,

B_t = the actual balance on principal at the end of month t,

$\tilde{B}_t$ = the conditionally scheduled balance on principal at the end of month t, that is the balance conditional on the actual balance in month $t - 1$ (B_{t-1}) but assuming no prepayments in month t,

S_t = the *survival factor* ($\equiv B_t/B_t^*$), that is the fraction of the originally scheduled balance at the end of month t that has not been prepaid,

p^* = the originally scheduled level mortgage payment,

p_t = the actual mortgage payment in month t,

$\tilde{p}_t$ = the conditionally scheduled payment in month t, that is the payment conditional on the actual balance in month $t-1$ (B_{t-1}) but assuming no prepayments in month t,

ρ_t = the *conditional prepayment rate* (CPR), that is, the prepayment rate in month t as a fraction of the conditionally scheduled balance at the end of month t. This rate is also called the *single month mortality* (SMM).

$\rho_{n,t}$ = the n-period geometric moving average prepayment rate from month $t - n + 1$ through month t.

$\bar{\rho}_t$ = the average prepayment rate through month t. If the CPR was constant and equal to $\bar{\rho}_t$ from month 1 through month t, then the balance at then end of month t would be B_t, the balance that actually occurred. This rate is also called the *life-to-date CPR.*

Prepayment Rates

Agency mortgage pools are composed of many similar, though not necessarily identical, mortgages. We treat each pool as though it were composed of many identical, $1 dollar mortgages. For example, a pool with an original balance of $1 million, a weighted average life at issue of 320 months, and a weighted average coupon at issue of 9.75 percent is treated as collection of one million $1 mortgages each with a maturity of 320 months and a coupon rate of 9.75 percent.

The CPR in month t is given by

$$\rho_t = \frac{\tilde{B}_t - B_t}{\tilde{B}_t} .$$

The numerator of this equation is the dollar amount of prepayments in the month t. At the beginning of the month, the conditionally scheduled end-of-month balance is $\tilde{B}_t$. If there are prepayments in month t, the actual end-of-month balance, B_t, will be less than $\tilde{B}_t$ by the amount of the prepayments. These prepayments are expressed as a fraction of $\tilde{B}_t$, the end-of-month balance that would have occurred if there had been no prepayments.

From the formula above, we see that we need $\tilde{B}_t$ and B_t to calculate ρ_t. B_t we observe: it is the actual balance at the end of month t. $\tilde{B}_t$ is given by

$$\tilde{B}_t = (1 + \tau)B_{t-1} - \tilde{p}_t .$$

$\tilde{p}_t$ is the level payment from a mortgage with an initial balance of B_{t-1}, a maturity of $m - t + 1$ months, and an interest rate of τ. Using standard mortgage arithmetic, we have

$$\tilde{p}_t = \frac{\tau B_{t-1}}{1 - \frac{1}{(1+\tau)^{m-t+1}}}$$

It is also useful sometimes to calculate n-period geometric moving averages of monthly prepayment rates. The n-period geometric moving average prepayment rate, $\rho_{n,t}$, is defined as

$$\rho_{n,t} = 1 - \left(\prod_{i=0}^{n-1} 1 - \rho_{t-i} \right)^{1/n}$$

Finally, to calculate the life-to-date prepayment rate, $\bar{\rho}_t$, it is easier to use a different, but equivalent, formula for the CPR. Note that the conditionally scheduled balance, $\tilde{B}_t$, is the balance that would occur at the end of month t if there were no prepayments between months $t - 1$ and t. The survival factor, S_t, measures the fraction of mortgages that have not prepaid yet, that is,

$$S_t \equiv B_t / B_t^* .$$

If there are no prepayments in month t, then the survival factor will not change, that is, S_t will be equal to S_{t-1}, and the actual and conditionally scheduled balances will be the same, that is, B_t will be equal to $\tilde{B}_t$. In this case,

$$\begin{aligned} S_{t-1} &= B_t / B_t^* \\ &= \tilde{B}_t / B_t^* \\ \Rightarrow \tilde{B}_t &= S_{t-1} B_t^* \end{aligned}$$

Substituting this expression for $\tilde{B}_t$ into the CPR formula above and rearranging terms implies that

$$\rho_t = \frac{S_{t-1} - S_t}{S_{t-1}} .$$

Let λ_t be the decay rate of the survival factor in month t, that is,

$$S_t = \lambda_t S_{t-1} .$$

Then

$$\begin{aligned} \rho_t &= \frac{S_{t-1} - S_t}{S_{t-1}} \\ &= \frac{S_{t-1} - \lambda_t S_{t-1}}{S_{t-1}} \\ &= 1 - \lambda_t \end{aligned}$$

If the prepayment rate were a constant, then the decay rate would also be a constant, that is, $\rho_t = \bar{\rho}_t + 1 - \lambda$. In this case,

$$\begin{aligned} S_t &= \lambda^t S_0 \\ &= \lambda^t \quad \text{(since } S_0 = 1\text{)} \\ \Rightarrow 1 - S_t^{(1/t)} &= \bar{\rho}_t \end{aligned}$$

Calculating the n-period geometric moving average prepayment rate is also easier using survival factors. Generalizing from above,

$$\begin{aligned} S_t &= \lambda_t \lambda_{t-1} \cdots \lambda_{t-n+1} S_{t-n} \\ \frac{S_t}{S_{t-n}} &= \lambda_t \lambda_{t-1} \cdots \lambda_{t-n+1} \\ &= (1 - \rho_t)(1 - \rho_{t-1}) \cdots (1 - \rho_{t-n+1}) \\ &= \left(\prod_{i=0}^{n-1} 1 - \rho_{t-i} \right) \end{aligned}$$

$$\begin{aligned} & = (1-\rho_{n,t})^{n} . \\ \Rightarrow\ 1-\left(\frac{S_t}{S_{t-n}}\right)^{1/n} & = \rho_{n,t} \end{aligned}$$

Filtering the Prepayment Rates

Applying these formulae mechanically produces some anomalous prepayment rates. For the FNMA data, these formula produce *no* prepayment rates of exactly zero, however the preponderance of calculated prepayment rates are clustered near zero. In addition, these formula produce a small number of negative prepayment rates, most small but some not so small.

After consulting with FNMA and conducting a number of experiments on our own, we concluded that these anomalies are most likely due to errors in measuring the weighted average coupon (WAC) and the weighted average maturity (WAM) of the pools. FNMA reports these two values only as of the origination date of the pass-through security, and they are never updated.[75] Over time, these reported values diverge from the true values, particularly the reported weighted average maturities. It turns out that calculated prepayment rates are very sensitive to small changes in the WAM, especially for older mortgages.

To overcome this difficulty, we applied a filter to the calculated prepayment rates. We were informed by mortgage servicers that mortgage borrowers occasionally make partial prepayments. Apparently, it is not unusual for one in ten mortgage borrowers to make a double payment in any given month. We incorporated this information by assuming that measured prepayments of less than one-tenth the scheduled payment reflected measurement errors in the WAC or the WAM or both. These measured prepayments were arbitrarily set to zero. All apparently negative prepayments were also set to zero; every one of these occurrences could plausibly be the result of mismeasurement of the WAM. In addition, FNMA confirmed that there were, in fact, no negative prepayments.

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[75] FNMA has a telephone service which provides updated WACs and WAMS. However, the monthly Bond Buyer tapes do not incorporate these updates, at least in the tapes we used.

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